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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Experimental Researches in Propeller Cavitation—No. III.

The Velocity of Flow in Pipes.

Manufacture of Ferro-Vanadium by the Electric Furnace.

Links in the History of the Locomotive.

A Wireless Valve-Repairing Works.

Gas Turbines.

Polar Diagrams for Riveted Connections.

Public Works and Transport Exhibition (No. III).

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. STEEL TYRES for RAILWAY CARRIAGES and WAGONS.
2. HYDRAULIC PLANT—PUMPS, Three-throw, Horizontal, Motor Driven: ACCUMULATOR, SPRING BUCKLE PRESS, SPRING SCRAGGING PRESS and FORGING PRESS, Four-column Type. URGENTLY REQUIRED.
3. TURBO-ALTERNATOR SET, CONDENSING PLANT, CRANES, BOILER, ECONOMISER, PUMPS, STEEL CHIMNEY, STEAM and EXHAUST PIPE WORK, SWITCHBOARD, MOTOR CONVERTER SET, ROTARY CONVERTERS, SUB-STATION PLANT, EXTRA HIGH-TENSION FEEDER CABLES and AUXILIARIES for NEW POWER STATION and SUB-STATION at DELHI.

Tenders for this plant will be referred to India for consideration.

Tenders due on the 28th December, 1923, for No. 1, on the 4th January, 1924, for No. 2, and on the 14th January, 1924, for No. 3.

Tender forms obtainable from above. 4332

Senior Assistant Engineer for Railway Survey REQUIRED by the NIGERIAN GOVERNMENT for a tour of 12 to 18 months' service. Salary £540, rising to £720 by annual increments of £30 and thence to £920 by annual increments of £40. Outfit allowance of £60 on first appointment. Free first-class passages and camp equipment. Liberal leave on full salary. Candidates, not over 40 years of age, must be fully qualified engineers with experience in railway location.—Apply at once in writing, stating age and giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W., quoting at the top of application M/12,378. 4354

The Government of India REQUIRE the SERVICES of an INSPECTOR for the INDIAN STORES DEPARTMENT.

Three years' agreement, with possibility of extension. Pay at the rate of Rs. 500 per mensem, rising by annual increments of Rs. 50 per mensem to Rs. 750 per mensem. Local allowance of Rs. 50 per mensem while stationed at Calcutta, and house allowance of Rs. 50 per mensem if married and family residing with him in India. A first-class passage to India will be provided for the candidate selected.

QUALIFICATIONS.—Candidates must be of good general education, have served apprenticeship in engineering workshop, and have drawing-office experience. Special experience in construction of steel bridge work and good knowledge of theory and design of structures essential.

Letters of application, stating full particulars of age, education, training and experience, giving dates, with copies of testimonials and references, will be received, not later than 29th December, 1923, by the SECRETARY to the HIGH COMMISSIONER for INDIA, 42, Grosvenor-gardens, London, S.W. 1, from whom further particulars may be obtained. 4334

University of Birmingham.

FACULTY OF SCIENCE.

PROFESSORSHIP OF CIVIL ENGINEERING.

The Council of the University invites APPLICATIONS for the CHAIR of CIVIL ENGINEERING.

The stipend will be £1000 a year.

The Professor will be allowed to take higher consultative work, to keep in touch with civil engineering practice, provided that it does not interfere with his University duties.

Applications, accompanied by fifty copies of testimonials, should be received by the Secretary not later than February 4th, 1924.

The successful candidate will be expected to begin his duties on October 1st, 1924.

Further particulars may be obtained from

GEO. H. MORLEY, Secretary.

4329

The Norton and Gregory Annual

SCHOLARLHIPS IN ENGINEERING

(SECOND YEAR)

Offered by NORTON and GREGORY, Ltd., London.

HONORARY COMMITTEE:

Sir JOSEPH PETAVEL, K.B.E., D.Sc., F.R.S., Director of the National Physical Laboratory, Teddington (Chairman).

Professor C. E. INGLIS, M.A., Professor of Engineering, Cambridge University (Vice-Chairman).

Professor E. G. COKER, D.Sc., F.R.S., Dean of the Faculty of Engineering, University of London, University College, Gower-street, W.C. 1.

J. TALBOT, Esq., T.D., M.A., B.Sc., Master of Halleybury College, appointed by the Committee of the Headmasters' Conference.

G. H. BURKHARDT, Esq., M.A., M.Sc., Principal of Swindon and North Wilts Secondary School and Technical Institution, Swindon, appointed by the Incorporated Association of Headmasters.

REG. S. CLAY, Esq., D.Sc., Principal of Northern Polytechnic Institute, London, appointed by the Association of Principals of Technical Institutions.

Together with the Chairman and the Managing Director of Messrs. Norton and Gregory, Ltd.

Messrs. Norton and Gregory, Ltd., offer Two Engineering Scholarships, to be competed for annually, one value £100 per annum and one value £50 per annum, tenable for three years at any University in the United Kingdom or British Dominions approved by the Committee.

A sum sufficient to cover the Scholarships now offered has been deposited by the Donors in the names of the Chairman and Vice-Chairman of the Committee.

Candidates must have reached the age of 17, but not the age of 19, on 1st March in the year of examination, be domiciled in the United Kingdom, and undertake to pursue a three years' Course in Engineering with a view to following it as a profession.

Papers, which will cover two days' examination, will be set in the following four subjects :—

English,
Mathematics,
Mechanics,
General Physics.

The Examination for the 1924 Scholarships will be held on 28th and 29th February, and all Application Forms must reach the Committee not later than 21st January, 1924.

The Scholarships Awards will be officially published on 15th May, 1924.

Full particulars and official Application Forms may be obtained from

The SECRETARY,
SCHOLARSHIPS' COMMITTEE,
Messrs. Norton and Gregory, Ltd.,
1 and 2, Castle-lane,
Westminster, London, S.W. 1

4247

PUBLIC NOTICES

In the High Court of Justice Chancery Division 1923 E 071
Mr. Justice Romer
In the Matter of the EAST COAST STEEL CORPORATION Limited and Reduced
and
In the Matter of the COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that the ORDER of the High Court of Justice Chancery Division dated the 23rd day of November 1923 CONFIRMING the REDUCTION of the CAPITAL of the above-named Company from £5,000,000 to £4,322,814 and the Minute approved by the Court showing with respect to the Share Capital of the Company as altered the several particulars required by the above Act were registered by the Registrar of Companies on the 13th day of December 1923. The said Minute is in the words and figures following :—

The Capital of the East Coast Steel Corporation Limited and Reduced is henceforth £4,322,814 divided into 2,015,000 Preference Shares of £1 each (numbered 1 to 500,000, 570,001 to 600,000, 615,001 to 630,000, and 730,001 to 750,000 and 750,001 to 2,500,000) and 2,307,814 Ordinary Shares of £1 each (numbered 1 to 7 and numbered 192,194 to 2,500,000) instead of the former Capital of 5,000,000 divided into 2,500,000 Preference Shares of £1 each and 2,500,000 Ordinary Shares of £1 each. At the date of the registration of this Minute 265,000 of the Preference Shares (being those numbered 500,001 to 500,000 and 570,001 to 600,000 and 615,001 to 630,000 and 730,001 to 750,000) and 857,479 of the said Ordinary Shares (being those numbered 1 to 7 and 192,194 to 1,049,665) in the reduced Capital have been issued and the full amount of £1 has been and is to be deemed to be paid up on each of the said Shares.

The remaining 1,750,000 Preference Shares and 1,450,335 Ordinary Shares are unissued.

Dated this 13th day of December 1923.

JOHNSON WEATHERALL STURT & HARDY of 7, King's Bench Walk, Temple, London, E.C. 4, Solicitors for the said Company.

4363

City of Liverpool.

NEW STEAM HOPPER BARGE.

The Corporation of Liverpool REQUIRE a NEW STEAM HOPPER BARGE suitable for house refuse of approximately 1000 tons capacity, and are prepared to receive TENDERS from shipbuilders and engineers.

Copies of specification, general conditions, and form of Tender will be forwarded upon receipt of application in writing to the City Engineer, Municipal Buildings, Dale-street, Liverpool.

Sealed Tenders, addressed to "The Town Clerk, Municipal Buildings, Liverpool," and endorsed "Tender for New Steam Hopper Barge," must be forwarded through the post so as to be received not later than Twelve o'clock Noon on Tuesday, the 22nd January, 1924.

WALTER MOON, Town Clerk.

11th December, 1923. 4349

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :

1 MOTOR-DRIVEN WHEEL LATHE.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 7th December, 1923.

A fee of 10s. will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Thursday, 20th December, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS, Secretary.

4353

PUBLIC NOTICES

AMENDED ADVERTISEMENT EXTENDING TIME.

Belfast Union.

TO PROFESSIONAL CONSULTANT ENGINEERS.

PROPOSED CENTRAL HEATING AND LIGHTING SCHEME.

The Board of Guardians will, at their meeting to be held on Tuesday, the 18th day of March, 1924, receive from competent firms or persons qualified as above SCHEMES for the INSTALLATION and EQUIPMENT of a CENTRALISED HEATING and LIGHTING PLANT.

The Guardians will subsequently decide which is the best Scheme submitted, and the person or firm submitting same will be paid the sum of One Hundred Guineas.

Information as to plan of buildings and general conditions respecting the appointment and the proposal form may be obtained from the Clerk of the Union on deposit of the sum of Five Guineas, which will be returned after a bona fide proposal, with the necessary documents and particulars regarding such Scheme, has been received.

Proposals, sealed and endorsed "Central Heating and Lighting Scheme," with full particulars, are to be lodged with me before Twelve o'clock Noon on above date.

Arrangements for inspection of the buildings, if desired, can be made on application to Mr. J. Mahood, Workhouse Master, on any day (Sundays excepted) between the hours of Ten o'clock a.m. and Twelve o'clock Noon, from whom further information can be obtained.

(By Order),
R. H. WILSON, Clerk of Union.

Clerk's Office, Union Workhouse,
Belfast, 6th December, 1923. 4318

County Borough of Halifax.

The Tramways and Electricity Committee of the Halifax Corporation have FOR SALE ONE 750 K.W. CONTINUOUS CURRENT GENERATOR coupled to a HORIZONTAL SLOW-SPEED CROSS COMPOUND CORLISS VALVE ENGINE.

The above plant can be seen at any time by appointment and full particulars can be obtained on application to Mr. W. M. Rogerson, Borough Electrical Engineer, Town Hall-street East, Halifax.

Tenders for the above plant should be delivered to the undersigned not later than Saturday, the 22nd instant.

The highest or any Tender not necessarily accepted.

By Order,
PERCY SAUNDERS, Town Clerk.

Town Hall, Halifax,
6th December, 1923. 4360

Borough of Chepping Wycombe.

WATER INSPECTOR.

The Town Council invite APPLICATIONS from fully qualified plumbers for the POST of full-time WATER INSPECTOR, to act under the direction of the Manager of the Waterworks.

Preference will be given to candidates with experience with a Water Authority.

Duties : To inspect mains, meters and fittings, to advise water consumers and plumbers as to the installation of pipes, fittings and meters, to inspect and supervise the work of plumbers, and to make records.

Salary £308 per annum, payable monthly.

The appointment will be terminable by one calendar month's notice in writing on either side.

Applications, in candidates' own writing, endorsed "Water Inspector," stating age, experience, and present occupation, accompanied by copies of two recent testimonials, must be delivered to the Town Clerk, High Wycombe, by the 21st December.

Canvassing in any form will disqualify.

Dated this 5th day of December, 1923.

C. B. WOOD, Town Clerk.

4220

PUBLIC NOTICES

Borough of Portsmouth.

WIDENING OF THE CAMBER.

REINFORCED CONCRETE QUAY, &c.

The Portsmouth Town Council invite TENDERS for the CONSTRUCTION and MAINTENANCE in thorough repair for twelve calendar months from the completion thereof of the following WORKS, that is to say :—

The WIDENING of PORTSMOUTH CAMBER near the end of East-street, Portsmouth, by the REMOVAL of the PROJECTING QUAY WALL there, and the CONSTRUCTION of a REINFORCED CONCRETE QUAY WALL and other WORKS in connection with making good after the removal of the Camber Bridge, which is now being taken down.

Copies of the drawings and specification under which Tenders are invited can be obtained on application (accompanied by the sum of £3, which will be refunded on the return of the documents within seven days or on the receipt of a bona fide Tender accompanied by the documents required), to Mr. Arthur W. Ward, the Borough Engineer, Town Hall, Portsmouth, from whom any further particulars can be obtained.

The work will have to be carried out under the requirements of the Government Unemployment Grants Committee and the trade union rules in force in the borough.

Tenders must be accompanied by details showing how it is proposed to dispose the steel specified for the reinforced concrete, and those tendering may, if they desire, submit their own design for the reinforced concrete work, but no design will be considered unless accompanied by a firm Tender.

Tenders, marked "Tenders for Widening, Portsmouth Camber," are to be sent in on the form supplied, accompanied by the drawings, &c., issued by the Corporation, together with drawings, quantities &c., prepared by the person tendering, as required in the specification, and must reach the undersigned not later than 10 a.m. on Thursday, the 10th day of January, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

E. J. SPARKS, Town Clerk.

The Town Hall, Portsmouth,
10th December, 1923. 4341

Manchester Corporation.

The Rivers Committee invite TENDERS for the CONSTRUCTION of MAIN DRAINAGE WORK No. 5 (New Sewer, Great Ancoats-street, Swan-street, and Rochdale-road; from Adair-street to Market street, Blackley).

Plans may be seen and specifications, bills of quantities, and forms of Tender obtained on application at the City Engineer's Office, Town Hall, Manchester, on payment to the City Treasurer of £10 10s., which sum will, after the Corporation have come to a decision upon the Tenders received, but not before, be returned to the person submitting a bona fide Tender.

All cheques or postal orders are to be made payable to the order of "The Corporation of Manchester."

Tenders, enclosed in the official envelope and addressed to the Chairman of the Rivers Committee, are to be delivered at the City Engineer's Office not later than 9.30 a.m. on Saturday, the 19th January, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender.

P. M. HEATH, Town Clerk.

Town Hall, Manchester,
10th December, 1923. 4327

The Ministry of Public Works, EGYPT, are calling for TENDERS for the SUPPLY and ERECTION of a PUMPING PLANT to replace an existing steam plant at Qassassin. The contract will include the dismantling and removal of the existing plant. Firms quoting must send their Tenders direct to Egypt, where they are due 5th February, 1924.

Forms and specification, price 10s., can be obtained at the office of the INSPECTING ENGINEER, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1. 4302

SITUATIONS OPEN

WANTED, a Capable Young ENGINEER of Good address, to Represent an important Firm and Push Sales. Preference given to one who has a good general acquaintance with industrial engineering and some previous experience in interviewing firms to obtain orders.—Address, "ALPHA," Wm. Porteous and Co., Advertising Agents, Glasgow. P8390 A

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MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 645, Col. 1.

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SITUATIONS OPEN (continued)

WANTED, an Experienced COLLIERY MECHANICAL ENGINEER as Assistant to Chief Engineer of Group of Collieries in Co. Durham. University degree a recommendation. Must have experience of modern methods of winding and sinking; electrical knowledge important. Salary at rate of £500 per annum. The appointment may not be permanent. Age, qualifications, with copies of testimonials.—Address, 4351, The Engineer Office. 4351 A

AN Old-established COMPANY, at Present Doing a large business with railways and locomotive builders, DESIRE to obtain the SERVICES of a GENTLEMAN having the entree to Locomotive Engineers and Railway Purchasing Departments for the purpose of further developing their sales. Ex Railway Official preferred. Liberal salary and commission.—Write, stating past experience, qualifications, &c. Box 739, Sells Advertising Offices, Fleet-street, E.C.4. 4274 A

ASSISTANT GENERAL MANAGER REQUIRED by Constructional Engineering Firm established in India. Must be thoroughly competent engineer, having wide experience of Bridge, Jetty and Steel-frame Building Construction. Must also have commercial experience and ability to negotiate contracts. Public school or university man preferred. Age 34/42. Salary about Rs. 2000 per month and opportunity of participating in profits.—Address, giving fullest particulars, 4328, The Engineer Office. 4328 A

CHARGE HAND WANTED for Works in Northern Spain; must be thoroughly experienced in manufacture of Small Steel Tubes by Hot Sinking (including piercing, pilgering, and drawing), qualified to adjust and maintain all plant.

Also ONE experienced in similar work, but more especially qualified to supervise Cold Drawing and Galvanising

Applicants to give full details of experience, age, and salary required.—Address, 4333, The Engineer Office. 4333 A

CHIEF COST CLERK WANTED IMMEDIATELY by Firm in North-East England employing 500 hands.—Apply, stating age, experience, and salary required, to SUMMERSONS, Darlington. 4350 A

ENGINEER WANTED by a Large Firm of Engineers in the Midlands, to Take Control of the Engineering Side under the Managing Director. Applications only desired from those having the highest qualifications and experience in the design and manufacture of Heavy Oil and Gas Engines. State age, experience, and salary required. Applications will be treated as strictly confidential.—Address, 4330, The Engineer Office. 4330 A

SECRETARY-CASHIER REQUIRED for Engineering Works near Leeds; must be energetic and have initiative and be able to take charge of correspondence and control staff. Age 30-40.—Address, stating age, experience, and salary required, 4300, The Engineer Office. 4300 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE the SERVICES of a FOUNDRY WORKS MANAGER.—Apply in writing, enclosing photograph, to the FOUNDRY GENERAL MANAGER. 4284 A

WATERWORKS.—REQUIRED, WORKING ENGINEER and MECHANIC to Take Charge of Waterworks Pumping Plant of 1,250,000 gallons per day. Horizontal engines. Wages £4 per week, good house and coals. Situation 4 miles from nearest town. Applicants should state age and experience and forward three recent testimonials.—Address, 4266, The Engineer Office. Preference will be given to applicants with waterworks experience. 4266 A

WORKS MANAGER WANTED for an Old-established Machine Tool Manufacturing Firm, London district.—Address, stating age, salary required, and experience in full, P8418, The Engineer Office. P8418 A

WANTED, ENGINEER-DRAUGHTSMAN, with experience of Dock and Harbour Work and the preparation of plans for same. Age not over 35. Applicants should state age, salary required, giving particulars of experience and training in surveying and the preparation of drawings.—Address, 4231, The Engineer Office. 4231 A

A VACANCY Occurs in a London Drawing-office for a LADY TRACER. Neat, accurate work essential. Applications should be accompanied by the fullest particulars, together with a sample of work.—Address, P8413, The Engineer Office. P8413 A

ASSISTANT HEATING DRAUGHTSMAN REQUIRED by progressive London Firm of Heating Engineers. State age, experience, and salary required.—Address, P8433, The Engineer Office. P8433 A

DRAUGHTSMAN LEADING HAND WANTED for Estimating Department in Roof and Bridges Co. Must have experience in design of Steel-framed Buildings for home and abroad. State experience, salary expected.—Address, "400," Wm. Porteous and Co., Advertising Agents, Glasgow. P8428 A

DRAUGHTSMAN, Thoroughly Competent and experienced man, for design of various kinds of modern Gas Furnaces for all purposes. Experience in Oil Firing and Coal-fired Furnaces also desirable. State age, experience, and salary required.—Address, 4331, The Engineer Office. 4331 A

DRAUGHTSMAN WANTED by Firm of Consulting Engineers in Westminster, with experience in design of Structural Steel Work and Reinforced Concrete. Must be well trained and able to make own calculations.—Apply by letter, giving full particulars of experience, age, and salary required, to "CONSULTING," c/o Messrs. Brown's, 39, Tothill-street, Westminster, S.W. 1. 4362 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the design of Colliery Electric Winding Engines and Haulage Gears (mechanical portions). State age, experience, and salary required.—Address, 4289, The Engineer Office. 4289 A

FIRST-CLASS STRUCTURAL DRAUGHTSMEN REQUIRED; none but experienced men need apply. State full particulars, age, salary required.—THE CLEVELAND BRIDGE and ENGINEERING CO., Ltd., Darlington. 4076 A

REQUIRED, First-class DRAUGHTSMAN, Competent on Railway and Tramway Traction Motor Work.—Apply, THE ENGLISH ELECTRIC CO., Ltd., Dick, Kerr Works, Preston. 4320 A

REQUIRED for Important Argentine Railway, a first-class RAILWAY CARRIAGE and WAGON DRAUGHTSMAN, age under 25; commencing salary about £500 per annum on three years' contract; first-class passage provided.—Apply, giving age and details training and experience, with copies (only) of any testimonials, to Box G and W., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 4355 A

REQUIRED, SERVICES of Competent MACHINE TOOL DESIGNER, e.g., Milling Machines, &c., in London, to complete detail drawings of new special Milling Machine. Work could be done in spare time. Address, stating remuneration required, P8412, The Engineer Office. P8412 A

SENIOR and JUNIOR DRAUGHTSMAN REQUIRED for Electrical and Compressed Air Haulage Department; only experienced men need apply. State age, salary, experience, &c.—NORTONS (Tividale), Ltd., Tipton, Staffs. 4338 A

PRESS FOREMAN WANTED. First-class Man, accustomed to the production of Light and Heavy Pressings for All-steel Railway Carriages and Wagons.—Apply, Box 27, Leeds Advertising Agency, Standard Buildings, Leeds. 4321 A

SITUATIONS WANTED

A FULLY QUALIFIED CIVIL ENGINEER (M. Inst. M. and C.E.), with 7 years' experience in England and 18 in India, DESIRES a POST. Of undeniable integrity and holds excellent testimonials.—Address, 4273, The Engineer Office. 4273 B

ADVERTISER (38), Qualified by Examination and having long experience in British and foreign patent and trade mark matters with old-established firm of chartered patent agents as managing assistant in practice, SEEKS EMPLOYMENT as Consulting Patent Agent; good technical knowledge.—Address, P8429, The Engineer Office. P8429 B

CONSTRUCTIONAL ENGINEER (40), London, SEEKS CHANGE; technical and practical, with commercial initiative; accustomed to large contracts, control of inside and outside staff.—Address, P8429, The Engineer Office. P8429 B

ENGINEER (38), with Progressive Ideas and Good Initiative, DESIRES CHANGE. Wide and varied experience (practical and tech.), 1st Class B. of T. Cert., efficient designer, thorough knowledge of French, good tech. correspondent, highest references. At present head of research and experimental dept. in London.—Address, L. M., 14, Kensington Park-road, London, W. 11. P8302 B

ENGINEER (45), M.I.M.E., M.I. and S.I., thoroughly practical and commercial, of proved ability, 18 years' administrative experience with railway rolling stock, motor vehicles, and power plants, DESIRES POSITION as GENERAL MANAGER, REPRESENTATIVE, or similar. London district preferred. Salary £500 to £750.—Address, P8391, The Engineer Office. P8391 B

ENGINEER DRAUGHTSMAN (Age 37) SEEKS ENGAGEMENT, 12 years D.O. and 8 years shops, leading draughtsman, good technical knowledge, motor vehicles, general engineering, and jig and tool design. London district.—Address, P8340, The Engineer Office. P8340 B

EX-SERVICE MAN (24), University Edu., 4 Years shops and D.O., I.C. engines exp., SEEKS APP., Junior Draughtsman or Assist., home or abroad.—Address, P8430, The Engineer Office. P8430 B

FOUNDRY ENGINEER DESIRES POST where output is essential. Good organiser, 15 years' practical exp. in modern methods of mac. moulding, hydraulic, pneumatic, and electric jarr., patterns, patt. plates, jigs of all descriptions, also maintenance of works plant.—Address, P8417, The Engineer Office. P8417 B

M.I. MECH. E. (42) DESIRES CHANGE from present responsible position. High technical qualifications and some selling experience. Extensive experience of Diesel engines. Excellent credentials. Ambitious and hard-working. Willing to invest later in sound concern.—Address, P8421, The Engineer Office. P8421 B

SALES ENGINEER, Young, Experienced, at Liberty early New Year, SEEKS OPENING with reputable firm.—Address, P8415, The Engineer Office. P8415 B

WATERWORKS.—EXPERIENCE WANTED as SUPERINTENDENT'S ASSISTANT by G.I. Mech. E. Low salary.—Please write, P8428, The Engineer Office. P8428 B

WORKS MANAGER and DESIGNER (35), with 12 years' experience of aluminium die casting. Thorough knowledge of all branches of the trade. Estimating, design and making of dies, and operation of same in foundry.

Has recently developed and patented new process needing handling on a reasonable scale.

Further WORK DESIRED in another direction which would enhance the value of the process.

N., 11, Marlborough-road, Richmond, Surrey. P8424 B

WORKS.—BUILDING ASSISTANT to Chief Engineer DESIRES POST. Capable architect and surveyor, take control of new, alteration and maintenance work, able to organise works building dept. or control outside contractors, measure up, check accounts, extras and variations, write specifications, estimate, allocate costs, survey and supervise construction.—Address, P8416, The Engineer Office P8416 B

£1000 Per Annum Salary and Commission on turnover SALES MANAGER in Building Material and Engineering Trades, at present engaged, SEEKS CHANGE.—Address, P8409, The Engineer Office. P8409 B

COMMERCIAL RECONSTRUCTIONS, LTD.,

1, POST OFFICE CHAMBERS, DERBY.

Engineering undertakings reorganised by specialists.

Non-paying concerns reconstructed.

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Additional Capital in approved cases.

The fullest investigations are invited and required.

MISCELLANEOUS

A WELL KNOWN FRENCH MANUFACTURER of GAS ENGINES, with works in Northern France, WISHES to GET into TOUCH with a BRITISH MAKER of High-class Medium and Large-sized AIR COMPRESSORS with a view to making arrangements to MANUFACTURE such Air Compressors under licence in France.—Address, 4277, The Engineer Office. 4277 I

WEMBLEY EMPIRE EXHIBITION.

ADVERTISERS are PREPARED to UNDERTAKE SALESMAN DEMONSTRATION of MECHANICAL APPLIANCE at the above Exhibition by expert. Office equipment and stenographer supplied, also warehouse facilities, London.

DAWLEY ENGINEERING WORKS, Ltd., Dawley-road, Hayes, Middlesex. P8403 I

CONSULTING ENGINEER, Inventor, After Years of work on new machine, would be GLAD of a REPORT from Eminent Man as to its possibilities of working; can pay small fee.—Address, P8414, The Engineer Office. P8414 I

CONSULTING ENGINEER, with Good Established practice, OFFERED SHARE FURNISHED OFFICES, Trafalgar Square, on special terms. Fine modern building, exceptionally situated.—Address, 4272, The Engineer Office. 4272 I

FACTORY STORES.

A VERY CONSIDERABLE SAVING can be Effected in FACTORY STORES by introducing an efficient STORES SYSTEM.

A well-organised store represents reduction in the cost of production and increase in profits.

A simple and effective system suitable to any factory can be installed at a moderate charge by

Mr. J. H. BEER, Expert Factory Stores Organiser, 162, St. Leonards-road, London, S.W. 14. P8389 I

M.I. MECH. E., Travelling Argentina and Chile for celebrated oil engine manufacturer, DESIRES additional LINES, Compressors, Pumps, Electrical, or another important firm.—Address, P8422, The Engineer Office. P8422 I

PARTNERSHIPS

IF YOU ARE SEEKING

A PARTNER or PARTNERSHIP

or wish to buy or sell a

BUSINESS or WORKS

Write:

WHEATLEY KIRK, PRICE & CO.,

46, Watling Street,

London, E.C. 4.

Established over 70 years.

Company being formed to acquire Engineering Business in Midlands invites investment (£3,500) from gentleman having allied interests. Excellent opportunity to place son for training and attainment of important position. Particulars from A. Parton Smith, Solicitor, Waterloo Street, Birmingham. P8427 C

CONTRACTORS' AGENT, Having 16 Years' Experience high-class civil engineering contracting, with capital to invest, DESIRES UNDERTAKE TECHNICAL DIRECTION with Contracting Firm or to join other individuals in FORMATION NEW CONCERN.—Address, P8431, The Engineer Office. P8431 C

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THE PROPRIETOR of LETTERS PATENT Nos. 127,248, relating to FUEL AND LIKE PUMPS;" 127,249, relating to "ATOMISERS FOR LIQUID FUEL ENGINES;" 127,250, relating to "LIQUID FUEL ENGINES;" 127,251, relating to "TWO-STROKE LIQUID FUEL ENGINES;" 173,221, relating to "IGNITION DEVICES FOR INTERNAL COMBUSTION ENGINES;" 173,222, relating to "COMBUSTION CHAMBERS FOR INTERNAL COMBUSTION ENGINES;" 173,223, relating to "INTERNAL COMBUSTION ENGINES;" 173,224, relating to "FUEL INJECTING DEVICES FOR INTERNAL COMBUSTION ENGINES;" and 146,495, relating to "TWO-STROKE LIQUID FUEL ENGINES," DESIRES to DISPOSE of his PATENTS or to GRANT LICENCES to interested parties on reasonable terms for the purpose of EXPLOITING the same and ensuring its full commercial development and practical working in this country.—Inquiries to be addressed to

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1700 Feet 12in. M.S. Screwed and Flanged, Steam.
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FOR SALE, 200 B.H.P. DIESEL ENGINE, Four cylinders, 450 revs. per minute. Erected new 1913; can be seen working. Reason for selling, installing 450 B.H.P. engine. Will be sold cheap for prompt removal.—Apply, J. and R. WEBB, Ltd., Flour Mill, Mallow, Ireland. 4339 G

For continuation of For Sale Advertisements see page 3

A Seven-Day Journal

Waterloo Bridge.

Of all the bridges that span the Thames, Waterloo Bridge, in the opinion of most people, is easily the peer in the matter of artistic beauty. It is, therefore, somewhat disquieting to learn that, structurally, its condition to-day is such as to call for investigation. On the Lambeth side of the centre arch the pier is reported to have shown signs of settlement, and accordingly Mr. Basil Mott has been instructed by the Highways Committee of the London County Council to investigate and report upon the matter. It is understood that the work of investigation will probably present some difficulty by reason of the design of the bridge and its influence upon the erection of the necessary staging, and that it may be essential to employ divers to complete the examination. Until Mr. Mott has made his report, speculation as to the cause of the alleged settlement is idle, but it may be remarked that it would seem strange to us if it should have been caused, as one London newspaper suggests it may, by the alteration in flow of the river produced by the construction of the Embankment, for such a cause ought, by itself, to have acted many years ago. The bridge is a granite-faced structure. It was designed by the elder John Rennie, and was in the first stages of erection when the Battle of Waterloo was fought. It has nine elliptical arches, each of 120ft. span and with a rise of 34ft. The piers are 30ft. thick at the base, and the roadway is 28ft. in width. It is all too narrow for the traffic which now crosses it, and it may be that, as an outcome of the defect alleged to exist in it, it will be proposed to widen it as Sir Benjamin Baker, in the early years of this century, widened Rennie's other structure, London Bridge.

West Indian Cable Extension.

In connection with the proceedings at the recent Imperial Conference, it was announced that the all-British system of submarine telegraph cables was to be added to in an important and much-desired respect, namely, by the provision of a new cable from Turks Island—one of the Bahama group—to Barbados, at which point it would divide into two branches, one of which would go to Trinidad and the other to British Guiana. The total length of this new cable is 1700 nautical miles. The order for it, we understand, has now been placed with Messrs. Siemens, of Woolwich, who have contracted to manufacture and lay it before next summer.

The Kidderminster Sugar Factory.

Progress is being made towards the establishment of a sugar beet factory at Kidderminster. The company promoting the scheme is the British Allied Corporation, Limited, with the Skoda Company as engineers. The Skoda Company has already been responsible for the erection of beet sugar factories in Poland, Russia, France and Italy. Although its headquarters are in Czecho-Slovakia, it is, nowadays, practically a French company since Messrs. Schneider acquired a controlling interest in it. It appears that British engineers still find some difficulty in supplying the plant required in a sugar beet factory, and that, in especial certain parts in the manufacture of which they have had no experience prevent their competing satisfactorily with their foreign rivals. Were it not for this fact, it would have to be regretted that the Kidderminster plant is to come from abroad. At the Kelham factory the equipment was supplied by a French firm—the Fives-Lille Company—while at the Cantley establishment it was obtained from Holland.

Channel Crossed by Light Aeroplane.

A distinct step forward in the development of the light aeroplane seems to be implied in the fact that on Sunday, Mr. Alan Cobham, on a de Havilland "Humming Bird" light aeroplane, flew from Lympne to Berchem, near Brussels, in 4¼ hours. Last May, it is true, M. G. Barbot flew—or, rather, glided—across the Channel in a light aeroplane, but, as compared with his 15 horse-power engine, Mr. Cobham had the advantage of one of but 6 horse-power. This performance, on such a tiny low-powered machine, is all the more noteworthy by reason of the fact that the present is, perhaps, the worst flying period of the year. The de Havilland light aeroplanes, it may be recalled, gave a very good account of themselves at the autumn meeting at Lympne, one of them achieving 87 miles for a consumption of 1 gallon of petrol, and another effecting, during the week, an aggregate flight of 925 miles.

New Great Western Turbine Steamers.

The directors of the Great Western Railway, it is understood, intend shortly to call for tenders for the building of two oil-fired turbine vessels to replace the well-known steamers Ibex and Reindeer on the company's Channel Islands service. The new vessels will have a length of 290ft., a beam of 40ft., and a speed of 19 knots, and will be similar, as regards accommodation, to the company's steamers on the Fishguard-Rosslare route. The Ibex was built at Birkenhead in 1891, and has had an eventful career, having, in turn, struck a rock off Jersey, been in collision off Weymouth, and been sunk and salved at the entrance to St. Peter Port. The Reindeer, on the other hand, has been a lucky ship, for, except for some damage from Turkish shells which she suffered during the war when acting as a despatch and convoying vessel in the Mediterranean, she has never sustained a mishap. She was built at Barrow in 1897.

American Helicopters.

After expending close upon £50,000 upon helicopter experiments, the United States Aeronautical authorities have apparently come to the conclusion that they have done enough to demonstrate the practicability or impracticability of helicopter flight. The announcement, at any rate, has been made that the machine on which experiments have been proceeding is to be deposited for exhibition purposes in the Air Service Technical Museum. At the same time, no doubt simply to safeguard themselves, the American Army and Navy Air authorities are offering a prize of about £50,000 for a helicopter which can fulfil certain specified requirements. The helicopter specificially referred to in the official announcement is presumably the de Bothezat machine, concerning which reports of short flights or hops have been received from time to time during the past year or so. Meanwhile our own Air Ministry's helicopter competition, also for a prize of £50,000, still remains open, the closing date for entries being not until April 30th next year. The stringent, not to say difficult requirements to be fulfilled by the successful machines in this competition seem still to be quite beyond practical attainment, and, as in the case of the American competition, we can continue to adhere to the view that the contest was designed less with the hope that it would result in the emergence of a practical type of helicopter than with the object of avoiding the appearance of hostility to the idea.

The Loss of the Trevessa.

The findings of the Board of Trade Court of Inquiry appointed to investigate the circumstances of the loss of the steamship Trevessa in the Indian Ocean on June 4th, are of general interest insomuch as they reflect upon a common method of stowing certain types of cargo. The vessel was lost, the Court finds, by springing a leak, as a result of which one of the holds was rapidly filled. The exact cause of the leak is not positively known, but the Court is strongly of the opinion that it was continuous excessive straining produced by the severe weather encountered and the nature of the cargo—zinc concentrates. Dealing with the stowage of the cargo, the Court remarks that although the method adopted was one that had been in use for many years, it nevertheless constituted a danger to the ship. The cargo was properly secured against shifting, but it was composed of a substance of high specific gravity, which was almost impermeable by water, and was loaded in such a way as to convert each hold into a practically water-tight compartment. As a consequence, any water entering a hold could not escape to the bilges, could not be dealt with by the pumps, and could not be detected by sounding. The Court believes that it is possible to eliminate the danger indicated to a great extent, and suggests that the Board of Trade should institute an inquiry as to how best the object sought might be achieved, with due regard to mechanical, economic and practical considerations.

The Imperial College and Dominion Students.

Through Lord Buckmaster, as Chairman of the Governing Body of the Imperial College of Science and Technology, some private individuals, whose names have not been revealed, have offered to the Universities of the Dominions and India post-graduate scholarships of a value of £300 each tenable at the Imperial College. There will be two such scholarships for each country, and the selection of the students to receive them will be left in the hands of the Dominion Premiers or in those of the representatives of India. This offer, under which the resources of the College will be brought within the reach of overseas Empire students, has been duly accepted, and arrangements are to be made to give it effect.

Aeronautical Research.

The announcement referred to in a preceding paragraph regarding the abandonment of the official experiments in America on helicopters and our comments upon the forthcoming British competition for this class of flying machine, may be supplemented by a note on the attitude of the Council of the Royal Aeronautical Society towards aeronautical research in general. At a recent interview with Sir Samuel Hoare, the Council expressed its regret that it could not detect any signs that applied scientific research in aeronautics was being less submerged than formerly by technical *ad hoc* experimental work. The recent performances of American aeroplanes in speed endurance and climb, the Council contended, were the direct results of applied research, and could not fail to invoke comparison unfavourable to British progress in the same period. It expressed particular regret at the Air Council's decision to offer a prize of £50,000 for helicopters, characterising such machines as highly speculative constructions, introducing many difficult problems and carrying a vastly greater risk to life than any type of aeroplane in use. In view of the large number of subjects urgently requiring investigation in connection with the aeroplane, the Council was definitely of the opinion that expenditure on the development of the helicopter was unjustified.

French Naval Programme.

When France took stock of her naval defences after the war, she found that a very large proportion of the vessels were out of date, and that the remainder were no longer suitable for the changed conditions of naval warfare. A new naval programme was, therefore, drafted, in which light and fast cruisers, submarines and aircraft occupied a prominent part, not only for the reason that they appeared to fulfil the special conditions of French naval policy but because they were supposed to give the best return for the necessarily limited expenditure permitted by the country's financial situation. The first part of this naval construction programme was begun last year, when work was started upon three cruisers of 8000 tons, which are expected to rank amongst the fastest in the world, six destroyers, twelve torpedo-boats and six small submarines, while the battleship Béarn was to be transformed into a seaplane carrier. The work on all these vessels is now well advanced. The second part of the programme, involving an expenditure of 2356 million francs, will soon come up for debate in the Chamber of Deputies. It provides for the construction of six light cruisers of 10,000 tons, fifteen destroyers of 2400 tons, twenty-four torpedo-boats of 1450 tons, four submarine cruisers of 3000 tons, thirty first-class submarines of 1300 tons, two mine-layers of 4000 tons, and four oil-tank steamers of 10,000 tons. A large part of the work is to be carried out in private shipyards. The building of the vessels already under construction has been accelerated in a way that proves the efficiency of the yards entrusted with the work.

The Late Lord Shaughnessy.

Lord Shaughnessy, one of the prominent personalities connected with the building up of the Canadian Pacific Railway and for a lengthy period its president, died at Montreal on Monday in his seventy-first year. He was of Irish descent and of American birth. His first railway experience was gained on the Chicago, Milwaukee and St. Paul Railway, the purchasing department of which undertaking he entered at an early age. In this employment he became intimate with Mr. William Van Horne who, in 1882, was asked to assume command of the Canadian Pacific Railway, then emerging from its preliminary stages, and who prevailed upon Shaughnessy to accompany him across the border. For two years Shaughnessy served in the Canadian Company's purchasing department. In 1884 he was appointed assistant general manager, and in 1898 succeeded Sir William Van Horne as president. Under his able and energetic rule the company was developed to a most remarkable degree, not only in the matter of constructing railway extensions but by the building of hotels and other subsidiary works in Canada, and above all by the establishment of large and important steamship services on the Atlantic and Pacific. He was knighted in 1901 and raised to the peerage in 1916. In 1918 he retired from the presidency of the Canadian Pacific Company, and was appointed its chairman.

Engineers for Motor Ships.

From January 1st, 1924, engineers of ships propelled by internal combustion engines will in general be required to possess "motor certificates" as distinct from the "ordinary certificates" issued to engineers of steamships. The Board of Trade, in a notice which has just been issued, has announced that it recognises that inconvenience may arise in the case of foreign-going motor ships after January 1st if the requirement were enforced without modification. It has accordingly decided to consider applications for the issue of temporary permits that will enable engineers who hold ordinary certificates of competency to act as engineers of foreign-going motor ships. The application should be made through the local examiner of engineers at least two weeks before the permit is required, and should indicate, among other matters, the extent of the applicant's workshop and sea experience, both with steam engines and internal combustion engines, particularly of the type installed in his ship. The permit, if issued, will in general hold good for twelve months' actual sea service, and will, therefore, enable the holder to complete the nine months' service in motor ships necessary to qualify for examination for a motor endorsement. The permit will lapse, it is added, if at the end of a year's sea service in motor ships the holder has not obtained a motor endorsement.

Experimental Researches on Propeller Cavitation.

No. III.*

The difficulty of striking at the first attempt an entirely satisfactory compromise between the fast-turning turbine and the propeller led to numerous difficulties with the first turbine-driven vessels, and in many cases it was found that the original screws were too small and that both larger diameters and greater areas gave more satisfactory results. Particularly was this the case with the "Tribal" class destroyers of the 1905–6 and subsequent programmes, while in certain later destroyer designs, revolutions far in excess of the most suitable were adopted with very adverse results on the efficiency of propulsion. The same comment might be made on the "Dreadnought" type battleships of the period.

Troubles due to cavitation were by no means confined to British-built vessels, and between 1898 and 1908 the United States Navy Department experienced its full share in both large vessels and small. The next theory of the causes of this phenomenon enunciated subsequently to the Barnaby and Parsons explanations thereof was due to Mr. D. W. Taylor, then Chief Constructor at Washington, who in his book on the speed and power of ships, published in 1910, reproduced the results of very extensive experiments conducted in the United States Government tank, many of which had already been described by him in papers read before the American Society of Naval Architects. Referring to cavitation, Mr. Taylor found "the then-accepted theory" inadequate. His view was that a limiting thrust pressure of 11.25 lb. as found in the Daring was a generally inapplicable criterion, as greater thrust had been successfully used, and, moreover, cavitation was also liable to appear at much lower pressures and at relatively low tip speeds, and he expressed the view that the prime factors involved in its production were :—(1) The speed of the blade through the water, which is conveniently measured by the tip speed; and (2) the shape of the blade section.

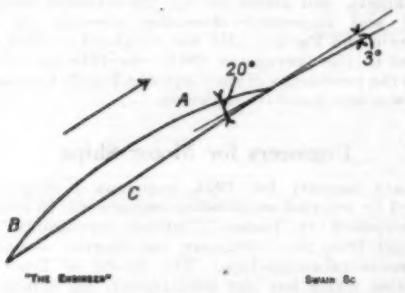


FIG. 2

The trials from which the optical proofs of the inception and development of cavitation were obtained by Sir Charles Parsons were made with very small but still models of a practical propeller, and comparison with full-size screws was made more closely approximate by relieving the water surface of a certain amount of pressure. In order to demonstrate the occurrence of cavitation in the cases of much larger models working in open water—models 16in. in diameter instead of 2in.—Mr. Taylor deliberately tested some of very abnormal proportions, and by making the pitch ratio very much less and the blade thickness greater than are ever encountered in practice, succeeded in producing cavitation in the open model basin, but in doing so he introduced conditions which bore little or no resemblance to those met with in practical work, and he thereby also entirely changed the character of the phenomenon from that suggested by Mr. Barnaby or photographed by Sir Charles Parsons. Abnormality of section or direction of advance with excess of blade speed must obviously detract from a screw's performance. In this case, the proportionate head of water above the blade tip was much greater than is usually met with in practice, and the shape of section and its circumferential speed out of all proportion thereto. Thus it was a matter, *in this case*, of whether the influence was greatest in one direction (excessive suction on blade back) or the other (abnormal blade section) and it somewhat naturally proved to be the latter. The experiment, however, was conducted intentionally in order to learn what occurred under extreme conditions, and if Mr. Taylor's theory, as deduced therefrom, be applied to actual ships' screws, there seems little doubt that the negative action at the back of the blades to which Mr. Taylor attributes much of the cause of cavitation, and which was also referred to by Sir Charles Parsons in 1897, may account for some of the falling off in efficiency observed in practice, but by no means a large amount unless the conditions *are* abnormal. As shape of section is considered a primary cause of cavitation in both the Taylor and the Gumbel theories, and, for normal sections, merely as a contributory factor in the Barnaby and Mumford theories, it may, perhaps, be considered here in some detail.

Obviously for the same blade thickness on centre line, the blade edge angles vary considerably with width of blade, as was discussed above in the case of the Drake. This extent is best exemplified by taking Mr. Taylor's 1904 series of model screws 16in. in diameter and pitch and of mean width ratio .075, .125, .200, .275, and .350. The last three correspond to the Froude series of .37, .51 and .65 disc area ratio: the first two are impracticably narrow. It may be remarked here that, compared with the Froude 1908 series of model screws, the United States experiments covered a wider range of pitch ratio but a lower and narrower range of area ratio and blade shape. Some detailed comparisons between the two sets of results published by Mr. T. B. Abell in 1910 prove close agreement to exist in reality, though it is not at first sight very apparent. In Fig. 1 it is seen that, at ⅔ radius, the variation of pitch due to the blade edge angles is very considerable, as the following table shows. Thus :—

Mean width ratio.	Pitch at			Difference from face pitch at	
	A.	B.	C.	Leading edge.	Trailing edge.
.075	− 5.3	+ 54.3	16.0	− 21.3	+ 38.3
.125	+ 4.8	+ 30.5	16.0	− 11.2	+ 14.5
.200	+ 7.8	+ 26.4	16.0	− 8.2	+ 10.4
.275	+ 10.0	+ 23.0	16.0	− 6.0	+ 7.0
.350	+ 11.0	+ 21.0	16.0	− 5.0	+ 5.0

Now Mr. Taylor's model "cavitators," as they have been called, had pitch ratios of 0.3 and 0.4, or face pitches of 4.8in. and 6.4in., so that when blade back influence is considered they were not far removed, geometrically, from being negative pitch screws, although possessing a positive face pitch.

Fig. 2 shows a propeller blade section advancing into water at an angle of slip of 3 deg. As regards the points indicated, Mr. Taylor held (1910) "that it does not appear possible for cavities to form at A. This portion of the section contributes negative thrust, and although the point of demarcation between the portion of the back contributing negative thrust and the portion contributing positive thrust (suction) probably varies in position with speed through the water and slip angle, it appears reasonably certain that A always contributes negative thrust and quite probably that this negative thrust increases indefinitely with speed.

"Over B a cavity will form when the speed is high enough. It will probably be small at first, and as the speed is increased cover a greater and greater portion of the back. It cannot cover the whole back, however, because it cannot extend over A to the leading edge.

"As regards C, it has generally been assumed that the thrust from the face always increases with increase of speed of section through the water."

As to why cavitation should cause the sudden loss of efficiency which it does when the blade section is pushed to high speed, Mr. Taylor offered the following explanation :—

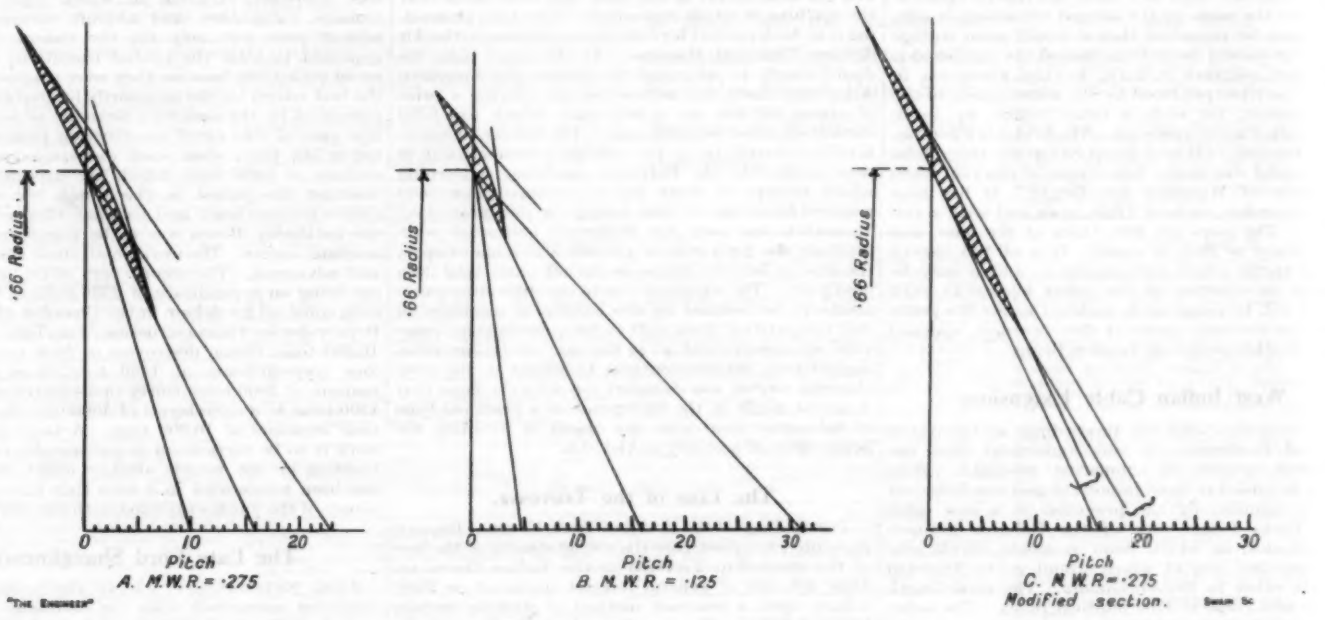


FIG. 1

A. "It is possible that when a vacuum is formed at B this portion of the blade contributes no more suction or thrust, while the negative thrust at A continues to increase, with resulting loss of efficiency. This explanation would seem to involve the further assumption that by far the major portion of the thrust of a propeller is due to suction of the blade back.

B. "It is possible that when a vacuum is formed at B it is spoiled by air obtained from the surrounding water and the suction of the blade back is decreased. This explanation is only possible if, when the water still hugs the blade back, it sweeps away any air which is sucked out of the water, so that while the water is still in contact with the blades it is possible for the latter to exert a suction approaching that of a perfect vacuum. But when the water breaks away from the back, air leaking into the space is carried away by entrainment only from the rear of the cavity, where the water comes together again, and when the rate of entrainment is equal to the rate of leakage into the cavity there is a balance of pressure, and though there is a partial vacuum in the cavity the pressure is much greater than a complete vacuum.

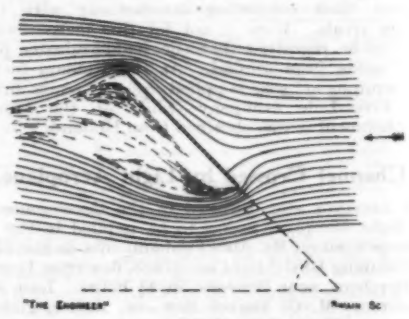


FIG. 3

C. "It is possible that when cavitation sets in the thrust from the blade face falls off relatively or absolutely.

"A, B and C appear to cover the possible theories of the phenomena associated with cavitation. Whether cavitation is due to one or more of these explanations, or to something different still, can be satisfactorily determined by experiment only, either on models or with full-size propellers."

Mr. Taylor went on to say that the cause of these

* No. II. appeared December 7th.

cavities seemed to be fairly obvious. Again referring to Fig. 2, he remarks that "The face C, advancing through water at an angle of 3 deg., which is not a small angle, is associated with the leading portions of the blade, whose direction is such that it is advancing through water at an angle of over 20 deg. Fig. 3 shows diagrammatically the nature of the motion of water past a plane with a sharp edge. In the case of a propeller we have virtually two planes in association, the face and the leading portion of the back. Considering the face alone, the water tends to cascade around the leading edge from front to back. Considering the back alone, the water tends to cascade around the leading edge from back to front. Acting in association, the back of the blade, with an inclination of over 20 deg., overpowers the face with an inclination of 3 deg., and as a result the water cascades from the back of the blade to the face around the leading edges, causing first eddies and then cavities on the face of the blade." Mr. Taylor proceeded: "If the cavities on the back were perfect, they would be helpful rather than harmful. . . . There is no question that when a curved surface is drawn through water at a sufficiently high speed cavities are formed over the rear portions. . . . The case of cavities on the face is different. They are due to an edge angle so large as to produce negative thrust from the leading portion of the back of the blade. They also nullify the thrust which the blade face would otherwise contribute, and are obviously fatal to efficiency." The remedy suggested by Mr. Barnaby for cavitation viz., the adoption of wide blades to keep down the pressure, also results in reducing the angle at the edges of the blades.

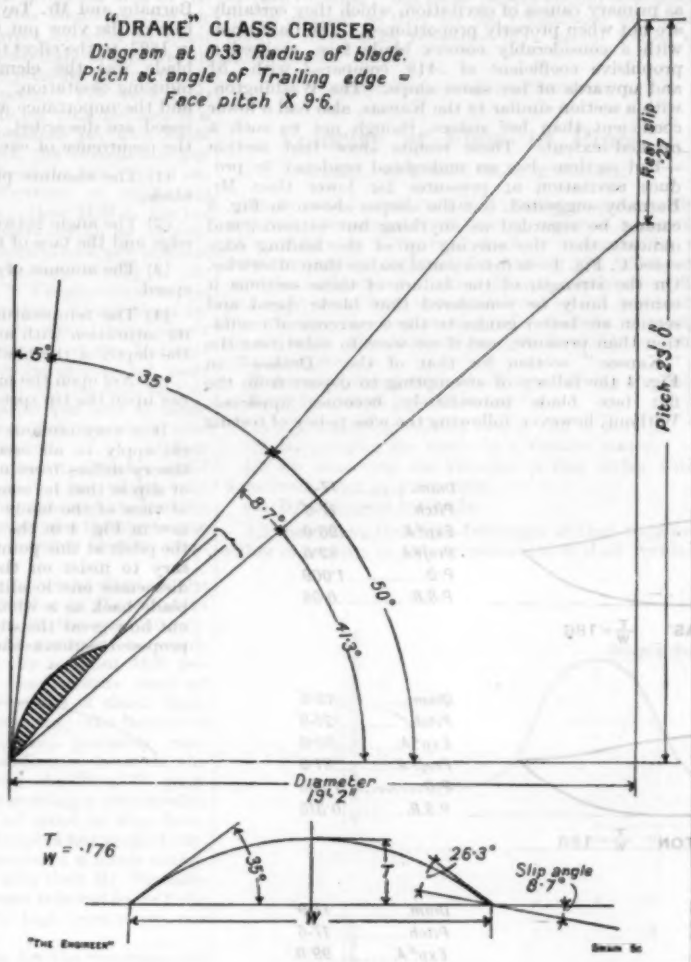


FIG. 4

It is not easy to agree with Mr. Taylor's insistence on face cavitation on the leading portion of the blade face, as it seems so entirely at variance with probability in practice and observation of blades in dry dock immediately after full-power trials. From his own sketch, Fig. 3, it would seem to be the most unlikely place on the whole blade for cavitation to occur if the propeller is properly shaped for high-speed work, and while it is possible or even probable that it does occur with thick narrow blades, and particularly if the entering edge be relieved, as shown in A and B, Fig. 6, it would appear far more likely for it to occur on the trailing face over the portion indicated in Fig. 5, as will be readily understood from a consideration of the slip diagram and the speeds involved. As Mr. Taylor states, it is probably certain that it very often occurs over the trailing portion of the back. Inspection of a considerable number of turbine-driven destroyer propellers in dock seems to show that the action indicated in Fig. 5 is what occurs with blades having a true screw face. In the case of several different destroyers, fitted with two, three and four shafts, the leading face in each case, even with blades of very different contour, was highly polished after full-power running, while the trailing face was affected to a much smaller extent. This marking was very consistent on each blade and cannot have been due to accident in view of the regularity of its appearance. All blades were hand polished before trial, but water friction eliminated these marks in parts and left them still distinct on patches A and B. The leading portion of the back was also polished, but the trailing portion of the back remained very dull, the dividing line between polished and dull surface being much nearer the leading edge on the back than on the face. It was very noticeable that with thicker blades this divergence was much more marked than with thin blades. Moreover, as regards the question of negative thrust due to the curved leading portion of the blade back, while there seems that there can be no doubt of its existence in the case of unduly thick blades and particularly in the case of cast iron blades with an edge formed as in sketch A, with blades of abnormally fine pitch ratio, or under the circumstances of extreme cavitation where a blade is merely scraping off layers of water, as suggested by Sir Charles Parsons, in the case of the working screw it is impossible to dissociate the action of a portion of the blade back from that of the back as a whole and which is admittedly producing suction thrust. It would appear more probable that this part is merely adding to the edgewise resistance of the blade, corresponding to drift in the case of an aerofoil, but *not* that it is causing the water to cascade round the blade edge from back to face. Sir Charles Parsons' later tank experiments showed precisely the reverse action.

Mr. Taylor's remedy for cavitation is the same as that which Mr. Barnaby suggested, but for a different reason, viz., the adoption of wide blades which, *per se*, involve thin edges. Section of blade *for this reason* has an important bearing on cavitation, while, *at the same time*, blade speed consequently becomes a factor of much less importance. Experience has proved that with screws of the wide tip, thin edge type peripheral velocities of 15,000ft. to 17,000ft. per

Diagram of Actual Destroyer Propeller of $P/D = 1{\cdot}0$ showing angles of advance and approximate areas on Front (A) & Back (B) of Blade left quite dull after 6 hour trial at 33 Knots. Remainder of area was highly polished by water friction.

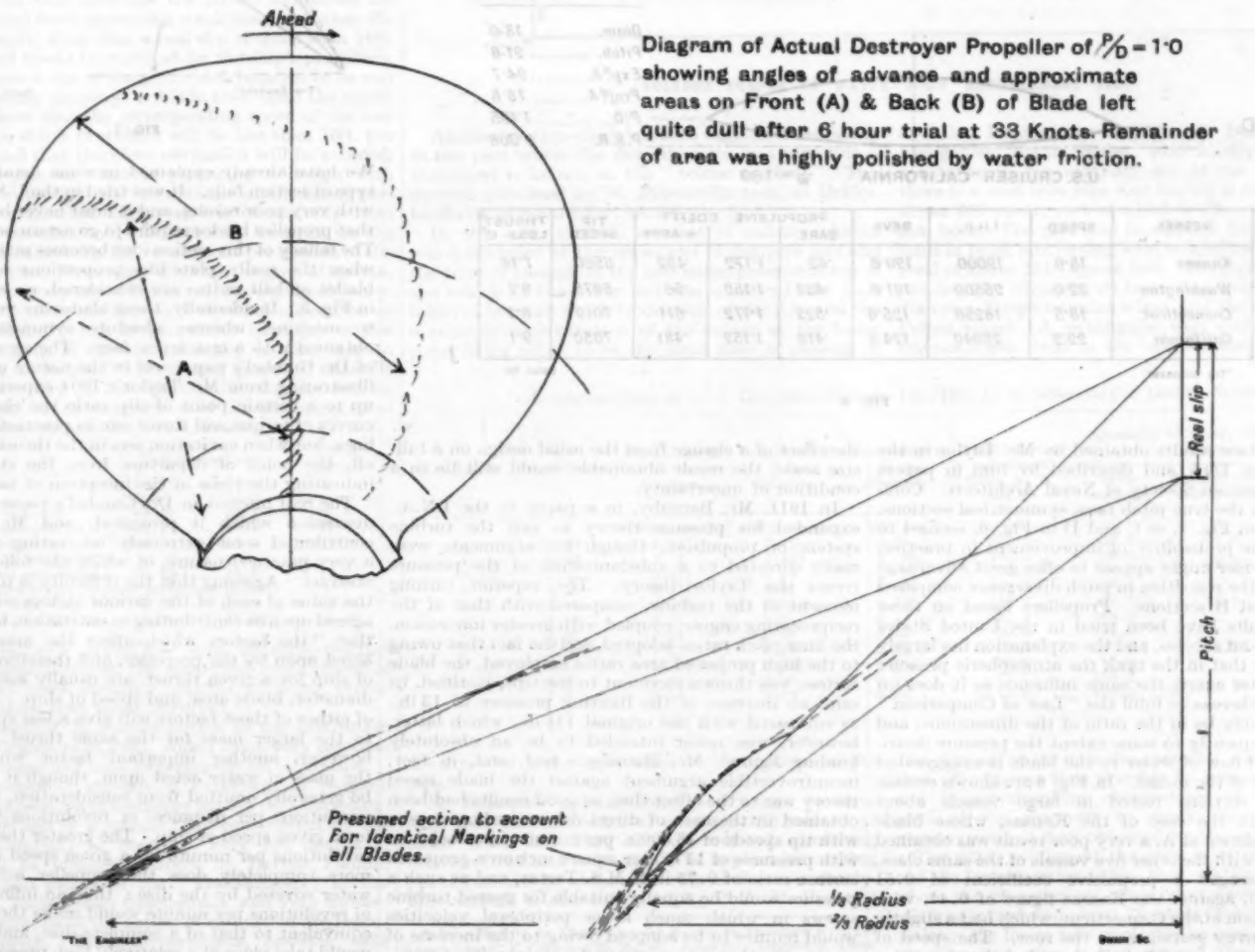
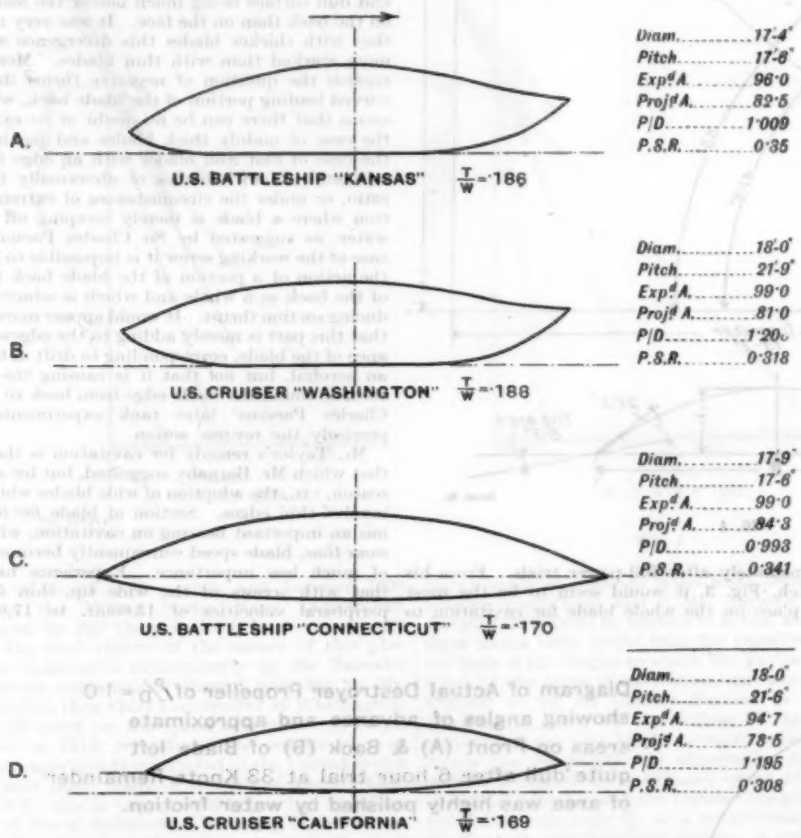


FIG. 5

minute are quite possible with good efficiency, always providing that the blade edges *are* sharp and not merely thin to within an inch or so of the edge and then rounded off bluntly. It is interesting to consider what would occur if a flat were to be filed on the leading edges of one of these tips, say, only ½in. wide and 4in. long. The maximum pressure on the edge is that due to a head equivalent to the velocity $= p = \frac{w V^2}{2g}$, where p = pressure in pounds per square foot, V = velocity in feet per second, w = weight of a cubic foot of sea water, and $g = 32.16$. At 15,000ft. per minute the pressure on this one-half of a square inch equals 216 lb., which works out to nearly 100 horse-power per blade. The "cavitation" which would ensue would be of a remarkable kind, and the blades would be badly eroded in consequence. The parting of the water would prevent a considerable area of the screw on either side of the blade from fulfilling its proper purpose and a considerable drop in efficiency would result. This, of course, is an extreme instance of the effect of tampering with blade edges; a slightly damaged edge has the same result.

Much of the attention given to blade section is due to certain results obtained by Mr. Taylor in the Washington Tank and described by him in papers to the American Society of Naval Architects. Compared with the true pitch face, symmetrical sections, such as C in Fig. 1, or C and D in Fig. 6, seemed to indicate the probability of improvement in practice, and the former might appear to offer great advantage in view of the reduction in pitch divergence compared with A and B sections. Propellers based on these model results have been tried in the United States Navy without success, and the explanation lies largely in the fact that in the tank the atmospheric pressure on the water exerts the same influence as it does on the ship, whereas to fulfil the "Law of Comparison" it should only be in the ratio of the dimensions, and that consequently to some extent the pressure distribution and flow of water to the blade is exaggerated in the case of the model. In Fig. 6 are shown certain abnormal sections tested in large vessels about 1906–7. In the case of the Kansas, whose blade section is shown at A, a very poor result was obtained compared with the other five vessels of the same class, which averaged a propulsive coefficient of 0.51 (bare hull), against the Kansas figure of 0.41, with the exception of the Connecticut, which had a slightly double convex section near the root. The speed of the Kansas was roughly half a knot less than her sister ships obtained, and the vibration was excessive. Much improved results were obtained by a change to normal section. Partly on the strength of the trouble with the Kansas at low blade tip speed and pressure, the speed and shape of section have been regarded as primary causes of cavitation, which they certainly are not when properly proportioned. The California, with a considerably convex blade face, realised a propulsive coefficient of .418, compared with .51 and upwards of her sister ships. The Washington, with a section similar to the Kansas, also had a lower coefficient than her sisters, though not to such a marked extent. These results show that section—bad section—has an undoubted tendency to produce cavitation at pressures far lower than Mr. Barnaby suggested, but the shapes shown in Fig. 6 cannot be regarded as anything but extreme, and indicate that the curving up of the leading edge—see C, Fig. 1—is detrimental rather than otherwise. On the strength of the failure of these sections it cannot fairly be considered that blade speed and section are better guides to the occurrence of cavitation than pressure, and if we were to substitute the "Kansas" section for that of the "Drakes" in Fig. 4 the fallacy of attempting to depart from the flat face blade immediately becomes apparent. Without, however, following the wise policy of testing the effect of a change from the usual design on a full-size scale, the result obtainable would still lie in a condition of uncertainty.



VESSEL	SPEED	I.H.P.	REVS	PROPULSIVE COEFF^T BARE		+ APP^G	TIP SPEED	THRUST LBS.P. C^T
Kansas	18·0	19000	120·6	·42	1·172	·492	6560	7·14
Washington	22·0	25500	121·6	·485	1·152	·56	6875	9·1
Connecticut	18·5	18250	125·6	·522	1·172	·611	7010	8·1
California	22·2	28940	124·6	·418	1·152	·481	7050	9·1

"THE ENGINEER" SWAIN SC.

FIG. 6

In 1911, Mr. Barnaby, in a paper to the I.N.A., expanded his pressure theory to suit the turbine system of propulsion, though his arguments were really directed to a substantiation of the pressure *versus* the Taylor theory. The superior turning moment of the turbine, compared with that of the reciprocating engine, coupled with greater immersion, the finer pitch ratios adopted, and the fact that owing to the high projected area ratios employed, the blade surface was thrown more out to the tips, justified, he said, an increase of the limiting pressure to 13 lb., as compared with the original 11½ lb., which latter, however, was never intended to be an absolutely binding figure. Mr. Barnaby's real, and, in fact, incontrovertible argument against the blade speed theory was to the effect that, as good results had been obtained in the case of direct-driven turbine screws with tip speeds of 15,000ft. per minute, in association with pressures of 13 lb. per square inch on a projected surface ratio of 0.75 in H.M.S. Tartar, and as such a pressure would be equally suitable for geared turbine screws in which much lower peripheral velocities would require to be adopted owing to the increase of pitch ratio, thrust seemed—and certainly does to us—to be a better guide than velocity. Mr. Barnaby adhered to his original version of his theory in his last book on "Screw Propellers," published in 1921.

The theory set forth by Professor Gumbel in 1913 deliberately controverted the views of both Mr. Barnaby and Mr. Taylor, and introduced an elaboration of the view put forward by Sir Charles Parsons in 1897, to the effect that the shape of the back of the blade was the element of salient importance in inducing cavitation. The theory of limiting pressure and the importance attached by Mr. Taylor to blade speed are discarded, Professor Gumbel opining that the occurrence of cavitation depended on:—

(1) The absolute pitch of the cross section of the blade.

(2) The angle between the tangent of the following edge and the face of the blade in cross section.

(3) The amount of slip as a function of the vessel's speed.

(4) The temperature of the water, the degree of its saturation with air, the barometric pressure, and the depth of the blade below the surface; and

(5) *Not* upon the mean pressure per unit blade area nor upon the tip speed.

It is very obvious that the elements arising under (4) apply to all cases. Where Professor Gumbel's theory differs from others in regard to the influence of slip is that he considers it entirely from the point of view of the blade angle at the trailing edge. We saw in Fig. 4 in the Drake's diagram how enormous the pitch at this point becomes, but again, it is necessary to insist on the fact that it is impossible to dissociate one locality on the blade back from the blade back as a whole, and Dr. Gumbel, in pointing out how great the slip is at this point, arrives at the proposed section as shown dotted in the sketch B, Fig. 7.

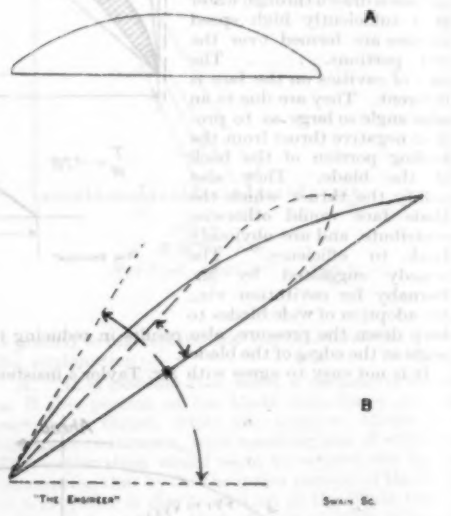


FIG. 7

We have already explained in some detail why this type of section fails. It was tried in the U.S.S. Denver with very poor results, and it must never be forgotten that propeller blades require to go astern occasionally. The fallacy of this section idea becomes more apparent when the really plate-like proportions of wide tip blades at half radius are considered, as will be seen in Fig. 5. Incidentally, these blades are very difficult to machine, whereas absolute symmetry can be obtained with a true screw face. The second portion of Dr. Gumbel's paper was in the nature of diagrams illustrating from Mr. Taylor's 1904 experiments how up to a certain point of slip ratio the characteristic curves of torque and thrust run in practically straight lines, but when cavitation sets in the thrust curve falls off, the point of departure from the straight line indicating the locus of the inception of cavitation.

The real interest in Dr. Gumbel's paper lay in the discussion which it provoked, and Mr. Mumford contributed some extremely interesting remarks of a very practical nature, of which the following is an abstract. Agreeing that the difficulty is to determine the value of each of the various factors which all are agreed upon as contributing to cavitation, he remarked that "the factors which affect the mass of water acted upon by the propeller, and therefore the speed of ship for a given thrust, are usually assumed to be diameter, blade area, and speed of ship. An increase of either of these factors will give a less speed of ship to the larger mass for the same thrust. There is, however, another important factor which affects the mass of water acted upon, though it appears to be generally omitted from consideration, and that is revolutions per distance, or revolutions per minute for a given speed of ship. The greater the number of revolutions per minute for a given speed of ship, the more completely does the propeller act upon the water covered by the disc; thus an infinite number of revolutions per minute would make the blade area equivalent to that of a complete disc, and cavitation would take place at a relatively high pressure per unit of blade area, while with no revolutions per minute

(*i.e.*, assuming a non-revolving propeller to be pushed aft from the stern of a ship at a speed V — *v*) the propeller could not act upon a greater proportion of the disc than is covered by the projected area of the blades; only in such a case as this would pressure per unit of projected area be a correct criterion for speed of ship and the occurrence of cavitation, and such a case would give the minimum pressure per unit area at which cavitation would occur. For very high revolutions per minute pressure per unit disc area is a much better criterion than pressure per unit blade area. The differences between the revolutions per minute of various vessels of about the same speed are the principal causes of differences in cavitating pressures per unit blade area; thus H.M.S. Daring was a 24-knot ship with propellers driven by reciprocating engines at about 380 revolutions per minute, and they broke down at a pressure of 11½ lb. per square inch of projected area." Vessels of about the same size and speed, with propellers driven direct by turbines (*i.e.*, no reducing gear), would have about double the revolutions per minute of the Daring's propellers, and would therefore be able to act more effectively on the water covered by the disc, and so have less slip for the same thrust per unit of blade area, and carry a greater thrust per unit blade area for a similar degree of cavitation. . . . When the speed of ship varies the amount of water acted upon by the propeller per unit time varies—the higher the speed the greater the mass and the less the slip for the same thrust, or the greater the thrust per unit blade area that can be carried for the same degree of cavitation.

"Numerous results of trials of actual ships on the Skelmorlie measured mile show that in those waters the phenomenon of cavitation, in the case of propellers of fine pitch ratio, will generally be manifested when the speed of real slip is about 16ft. per second, though theoretically the pressure head of atmosphere and water should permit of about three times that slip against zero pressure; the factors of gas absorption, temperature, &c., probably contribute largely to the great difference between the theoretical and the actual, the ebullition of gases and water vapour in the cavity creating a considerable pressure therein. This limit of speed of slip, however, is much higher than Dr. Gumbel has worked out, and in very many cases it permits of a much higher pressure per unit of projected area than Mr. Barnaby has conceded, owing to the causes referred to, not the least of which is the relatively high revolutions per distance.

"The most reliable criterion for the occurrence of cavitation is actual experiment with model propellers working behind the ship model fitted with brackets, at a speed of advance and thrust corresponding to ship requirements. Such experiments will integrate the varying effects of the principal factors—diameter, blade area and shape, pitch, and revolutions per minute—so that although the model conditions are far removed from cavitating conditions, yet when the model results show that a real slip of more than 16ft. per second would be required for the ship's propellers, it is at once a sign of danger, which requires to be met by increasing diameter, or blade area, until the model results show that the corresponding speed of the real slip of the ship's propellers will be less than 16ft. per second, and that therefore cavitation will be avoided. It often happens that in preparing a design with propellers having the minimum pitch ratio permissible, somewhat higher speeds of real slip than 16ft. per second may be deliberately incurred for the purpose of increasing the revolutions per minute of the turbines, thus permitting a certain degree of cavitation, with consequent reduction of propulsive efficiency. In all such cases the degree of cavitation must be so limited that the loss in propulsive efficiency is less than the gain in turbine efficiency or that due to reduction of weight." No clearer practical example of the accuracy of Mr. Mumford's remarks can be found than in the comparison of the performance of H.M.S. Mackay and the U.S.S. Pruitt.

	H.M.S. Mackay. Light load.	H.M.S. Mackay. Deep load.	U.S.S. Pruitt.
Speed in knots	35.46	32.4	35.0
Revs. per minute	383.4	334.6	442.5
Revs. per knot	595	618	723
Speed of real slip in feet per second	15.85	19.0	14.2
Recorded thrust pressure per square inch of—			
Disc area	9.29	10.4	8.63
Projected area	13.38	15.03	15.66

The Mackay's propellers were showing distinct signs of breakdown on the deep-load trial; those of the Pruitt were certainly capable of being driven harder before that point occurred.

Mr. Mumford, in a contribution to the Institution of Civil Engineers in 1921, added some very interesting data regarding tank experiments on cavitation.

A considerable amount of experimental research has been conducted in Germany both in the Charlottenburg Tank and in a special tank constructed by the Vulkan Company at Stettin. Very full details of these will be found in papers by Herren Flamm, Wagner, and others in the "Transactions" of the Schiffbau Technischen Gesellschaft, and very numerous photographs of the action of cavitation are reproduced therein. These experiments, however, add comparatively little to our knowledge, though the illustrations are very interesting and show the persistence of vacuum cavities extending some distance abaft the propeller and also the boss in a very marked manner. The photographs also indicate the extent of race rotation; but these papers should be studied in the original, as they are too voluminous to permit here of more than reference to a useful source of information.

Velocity of Flow in Pipes.

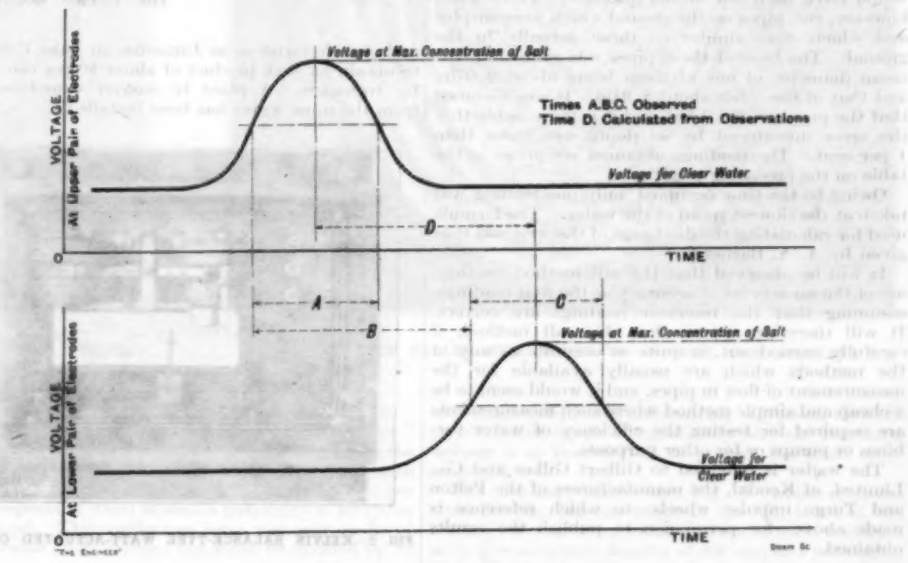
By ERIC CREWDSON, Assoc. M. Inst. C.E.

As is well known to all hydraulic engineers, the accurate measurement of flowing water is a matter of considerable difficulty. Such a measurement is very frequently required for testing the efficiency of water turbine units, either from a purely scientific point of view or from the commercial one of ascertaining whether the performance of a turbine or pump agrees with the guarantees put forward by the manufacturer.

There are several methods of ascertaining the rate of flow of water at present in use:—

(1) By observing the flow over a weir or notch.
(2) By gauging the water in a Venturi meter.
(3) By observing the velocity of flow either with a current meter or Pitot tube.
(4) By chemical methods.

All these have their disadvantages in that they are either expensive in use or uncertain in their results.



VOLTAGE CURVES IN WATER-FLOW MEASUREMENT TEST

Another system which has been suggested frequently in the past where the flow of water in a pipe line is concerned is known as the "colour method." This method was used by M. Ribourt in tests at Brides-les-Bains in September, 1903.*

In this case a small amount of colour solution was introduced at the upper end of the pipe line and the time of passage of the maximum concentration of the colour at the lower end was observed, the time interval between the introduction of the dye and the maximum concentration of the colour at the lower point being taken to be the mean time of passage of a volume of water equivalent to the volume in the pipe.

M. Ribourt's general conclusion seems to have been that this method over-estimates the velocity of mean flow, and that a coefficient of something between 0.90 and 0.95 should be applied in working out the results to obtain the rate of flow accurately. This method is also suggested by P. A. M. Parker.†

He claims a considerable degree of accuracy for it and certainly more than would be indicated by M. Ribourt's experiments or others which the writer has himself made on several occasions.

A modification of this method which the writer believes was first suggested in America and is at present being studied by Professor Allen, of Worcester Polytechnic Institute, is to introduce, instead of colour, common salt, either in solution or otherwise. The time of arrival of the salt solution at the lower end of the pipe is indicated by the reduction in electrical resistance between two electrodes fixed in the pipe in contact with the water. The time is measured from the introduction of the salt to the time of minimum resistance between the electrodes.

The writer has carried out some experiments exactly on these lines, but the results have not been entirely satisfactory, as it is difficult, if not impossible, to ensure that the salt is thoroughly mixed with the water immediately it is introduced. An obvious modification was to introduce the salt near the head of the pipe line and have two pairs of electrodes, relatively close to one another near the lower end of the pipe. By this means the salt would be thoroughly mixed with the water before it arrived at the upper pair of electrodes, and the time of mean passage of the maximum concentration of the salt between the two pairs of electrodes could be easily determined by voltmeter observations across them.

A very favourable opportunity of making such an experiment occurred recently in connection with a water turbine installation put in by Gilbert Gilkes and Co., Limited, for Captain W. Best, at Vivod, Llangollen, North Wales, who kindly gave every assistance in the carrying out of the tests. Here there is a cast iron pipe line having a total length of about 800 yards, part of which is 12in. bore and part 9in. bore. The pipe line is supplied from a reservoir built in brick and having a superficial area at overflow level of about 2540 square feet. The pipe line supplies two impulse wheels at its lower end, one being a 12in. diameter Turgo impulse wheel and the other a 15in. Pelton wheel. A rectangular weir without end contractions was fixed in the tailrace from the wheels.

Observations Taken at Vivod, Llangollen, September 14th, 1923, for G. Gilkes and Co., Limited, Kendal.

No. of test.	Time of day.	Time interval B on diagram.	Time interval A on diagram.	Time interval C on diagram.	Time interval calculated from A, B, and C.	Quantity of water, cubic feet per minute. Weir readings.	Drop of reservoir reading.	Salt method.
		Min. sec.	Min. sec.	Min. sec.	Seconds.			
1	12.58	4 44	1 2	2 21	323.5	27.2	27.97	26.3
4	3.45	3 7	1 43½	1 8½	189.5	50.5	48.44	50.1
5	3.54	2 57½	1 14	1 7½	174.5	50.5		48.7
6	4.10	2 11½	0 42	0 39½	131.5	66.6	65.5	64.7
7	4.14	2 12½	0 55½	0 51½	130.4	66.6		65.2
8	4.19	2 12	0 57	0 55	131.0	66.6		64.9
9	4.35	1 31	0 29	0 28	90.5	97.0	96.95	94.0
10	4.40	1 31	0 30	0 29	90.5	97.0		94.0
11	4.43	1 31½	0 35½	0 33½	90.5	97.0		94.0
12	4.57	1 14½	0 20	0 19	73.75	119.2	114.75	115.2
13	5.3	1 14	0 29	0 29	74.0	119.2		114.9

The flow of water into the reservoir was completely shut off; it was thus possible by means of the weir and by simultaneous observations of the drop in level of the reservoir to check very closely the measurement of flow obtained by the salt method.

The 12in. portion of the pipe is at its upper end and the lower portion is 9in. bore, all the lower length where the observations were taken being new. The salt was introduced about 20 yards from the reservoir outlet; the lower pair of electrodes was screwed into the pipe just after it had entered the power-house and before it reached the wheels, the upper pair being

* "La Mesure du Débit dans les Essais de Turbines Hydrauliques," by E. F. Côte and H. Bellet. Jules Rey, Grenoble. 1909.
† "The Control of Water," by P. A. M. Parker. Routledge. 1913.

similarly fixed 321ft. above. Direct current at 110 volts was available and leads were connected to each pair of electrodes through voltmeters. The electrodes used were ordinary sparking plugs, slightly modified.

A saturated solution of common salt was made, the quantity introduced into the pipe for each observation being about one gallon. The time occupied in the introduction of the salt was about five seconds in each case. It was found that as the salt passed each pair of electrodes the corresponding voltmeter rose, slowly at first and then rapidly, towards a maximum. The maximum reading was obtained for an appreciable time, and then the voltmeter began to drop, at first fairly rapidly and then more slowly, until it resumed its original reading for clean water. The rise of voltage indicated on the voltmeter was of the order of 30 volts, but depended to some extent on the velocity of flow.

If recording voltmeters had been available the type of diagram obtained would have been as illustrated on page 635. The thick line on the upper diagram refers to the upper pair of electrodes, and that on the lower diagram to the lower pair of electrodes. The times measured were A, B, and C, and it was assumed that the mean time of passage of the salt between the two pairs of electrodes was $B - \frac{A}{2} + \frac{C}{2}$, or that time indicated by D in the diagram.

The only point which it was not possible to check was the mean bore of the pipes, which had been already laid before it was decided to make these tests, and to have taken them up for measurement purposes would have been out of the question. There were, however, two pipes on the ground which were surplus and which were similar to those actually in the ground. The bore of these pipes was measured, the mean diameter of one of them being about 9.07in. and that of the other about 8.91in. It was assumed that the pipe was 9in. bore, and it is improbable that the error introduced by so doing was more than 1 per cent. The readings obtained are given in the table on the preceding page.

Owing to the time occupied, only one reading was taken at the slowest speed of the water. The formula used for calculating the discharge of the weir was that given by A. A. Barnes.‡

It will be observed that the salt method readings are of the same order of accuracy as the weir readings, assuming that the reservoir readings are correct. It will therefore appear that this salt method, if carefully carried out, is quite as accurate as any of the methods which are usually available for the measurement of flow in pipes, and it would seem to be a cheap and simple method where such measurements are required for testing the efficiency of water turbines or pumps or for other purposes.

The writer is indebted to Gilbert Gilkes and Co., Limited, of Kendal, the manufacturers of the Pelton and Turgo impulse wheels—to which reference is made above—for permission to publish the results obtained.

‡ "Hydraulic Flow Reviewed," by A. A. Barnes. Spon. 1916.

Manufacture of Ferro-Vanadium by Electric Furnace.

By E. KILBURN SCOTT, M. Inst. E.E., A.M. Inst. C.E.

VANADIUM comes principally from a deposit of patronite (vanadium sulphide) at Minasragra, in the Peruvian Andes, and from carnotite deposits in Colorado and Utah, where it is a by-product in the production of uranium and radium. The outputs in long tons of metallic vanadium have been as follows:

Year.	From Peruvian deposit.	From United States deposit.
1913	—	386
1914	4	404
1915	790	560
1916	760	411
1917	805	432
1918	229	246
1919	494	254
1920	1095	455

The Peruvian mines are owned by the Vanadium Corporation of America, which also has works at Bridgeville, near Pittsburg, for making ferro-vanadium. The mine is unique in being the highest in the world, namely, at about 16,000ft. It is connected by a narrow-gauge railway of 12 miles to Lake Pun Run, where another short line connects to the Cerro de Pasco Railway, which runs to the port of Callao.

The seams vary from 3ft. to 6ft. in thickness and are estimated to contain 16,500 tons of vanadium. Hillebrand gives the following analysis of a sample:—

	Per cent.
Sulphur	58.79
Vanadium	19.53
Silica	6.88
Alumina	2.00
Carbon	3.47
Iron	2.92
Nickel	1.87
Titanium oxide	1.53

The ore is carbonaceous, and is associated with vanadiferous asphalt. It is roasted at the mine to reduce the sulphur content. That which is now being mined contains much less V_2O_5 than formerly, and in order to cut down transportation and other expenses the company proposes to build a hydro-electric plant and electric furnaces at Jumasha, on Lake Pun Run, to obtain an even product of about 80 per cent. V_2O_5 for transport. A plant to recover vanadium salts from the mine water has been installed.

FIG. 2—KELVIN BALANCE-TYPE WATT-ACTUATED CONTROL

The electric furnace described below was designed by Messrs. B. D. Saklatwalla and A. N. Anderson, of the Vanadium Corporation of America, and it has several unique features. The input is 4000 kilowatts three-phase at 220 volts, 60 cycles. As will be seen from Fig. 1, it is built of cast iron segments bolted together, measuring 16ft. 4in. long, 12ft. 8in. wide, and 7ft. 10in. high. The total weight with roof and electrodes is about 80 tons, and it is on rollers so arranged that, when it needs re-lining, it can be quickly rolled away and to one side. A spare furnace already lined is then rolled into place, the change being effected in two hours. There are two tap holes in the side, one for metal and the other for slag.

FIG. 1—TWO 4000 K.W. 3-PHASE ELECTRIC FURNACES

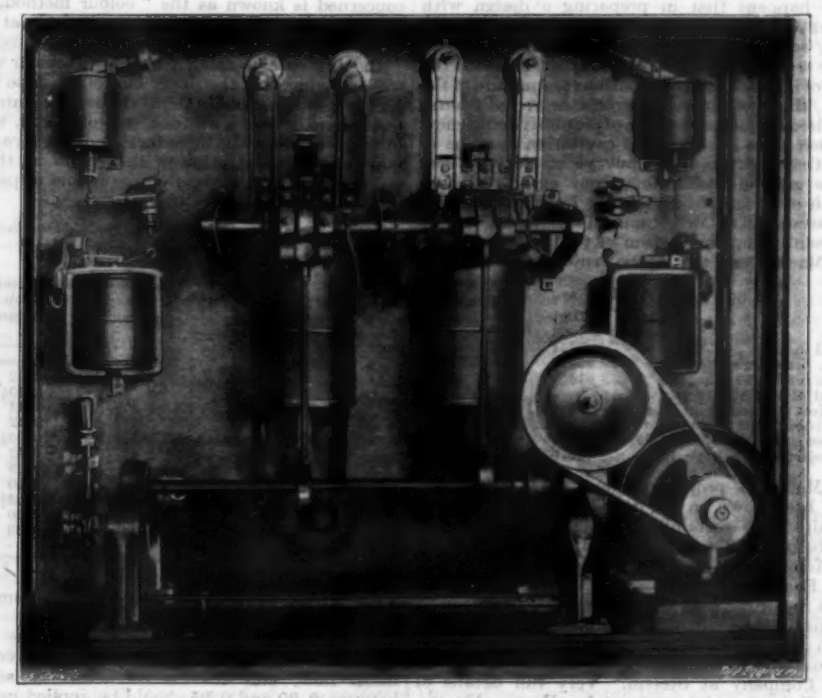


FIG. 3—CONTACT-MAKING CONTROL MECHANISM FOR ELECTRODE MOTORS

Round the sides next to the iron there is a layer of fire-bricks, inside which is a mass of tamped graphite. The hearth is made of blocks of electrode carbon 16in. square and of various lengths up to 10ft., leaving a rectangular space 8ft. 4in. long by 4ft. 8in. wide. In the bottom there are two layers of flint fire-brick, then a thick layer of crushed magnesite, over which graphite is tamped, and finally slabs of carbon.

The roof is arched with fire-bricks set in sections between rectangular pipes, through which cooling water circulates. The electrodes are of graphite, that material being chosen in preference to amorphous carbon because of the high current density, namely, 100 ampères per square inch. The diameter is 12in., which was the largest commercially available. Before being taken to the furnace each electrode has a copper ring wedged on to it by bronze wedges, and the outside of the ring is tapered to suit the inside of the holder over the furnace. The electrode with its ring is lifted by an electric crane and lowered into the holder, with which it makes friction contact by its own weight. There are no bolts or nuts to tighten up or any work to do over the furnace, where working is disagreeable. As the electrode and its ring heats up, the joint becomes tighter, because the ring expands into the holder casting, which is water cooled.

A motor and worm gear and winch raises and lowers each electrode at two speeds, namely, 2½ft. and 5ft.

per minute, the latter being used when the electrode is being removed. The furnacemen can change an electrode in a few minutes, and whilst doing so, current from the main control room is automatically cut off.

The regulating mechanism by which the electrodes are moved is unusually sensitive. One part of the mechanism consists of a watt balance—see Fig. 2—

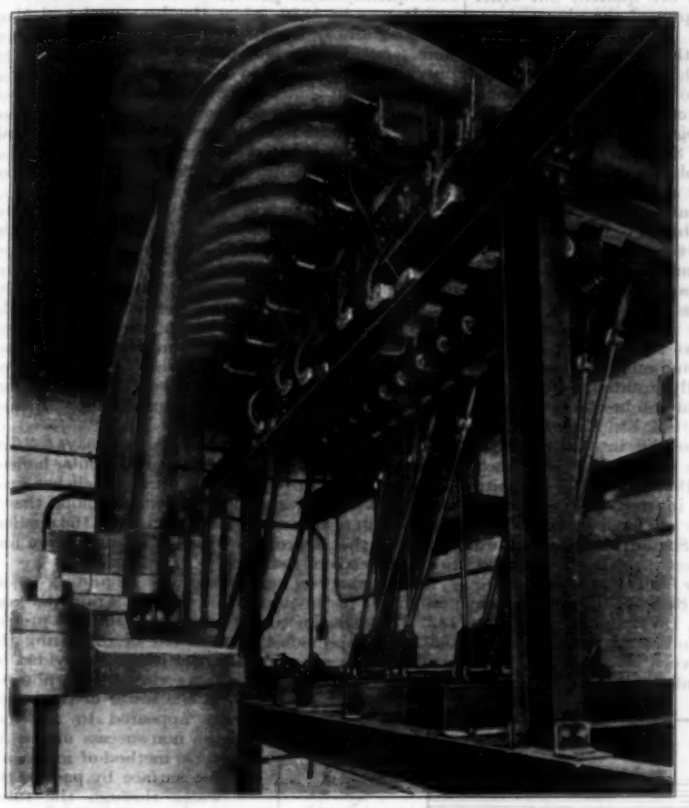


FIG. 4—TERMINALS OF BUS-TUBES, AND SHAFT-OPERATED KNIFE SWITCHES

FIG. 5—FURNACE CABLES WITH THOSE OF OPPOSITE SIGN ADJACENT

of the Kelvin type, the beam of which carries a volt coil at each end, balanced between two fixed ampère coils. At a predetermined wattage the beam coils float in balance, but as soon as fluctuation occurs the beam inclines and makes contact on one of two contacts. This contact actuates a second piece of apparatus, namely, a contact maker—see Fig. 3. This has two sets of contact arms, one having constant to-and-fro rocking motion, is driven through an excentric by a motor; the other actuated by a relay magnet receiving its impulses from the watt balance. When the rocking arms complete the circuit the electrode motor operates. There is also a selective device, which consists of magnetic relays connected across the phases with two magnets per phase for up and down motion of the electrodes. When the load in the furnace is balanced the magnetic pull on these relays is balanced. Phase unbalance in the furnace load causes a corresponding disturbance in the relays which open the circuit not affected by the disturbance and thus prevent movement of the electrodes unaffected by the disturbance. At the same time it causes the electrode affected to move in the correct direction required to restore balance. The magnets also prevent the electrodes from going too far into the bath of fused material.

The various regulating devices use alternating current as delivered to the furnace and at the same voltage, namely, 220. Direct current is not necessary. All the regulators, switches and instruments are in a separate and totally enclosed room. The instruments on each furnace include a graphic recording watt-meter, watt-hour meter, voltmeter, an ammeter on each phase, and a power factor indicator. The instruments of the first furnace installed were of the recording type, to facilitate study of the operations. The furnace may be regulated by hand as well as automatically, and all switching, except high and low-tension disconnecting, is done by remote control switches. When the isolating switches on the main busbars make the furnace dead the main transformer can still supply the motors and lighting.

The two power lines which bring energy to the factory at 22,000 volts are protected by lightning arresters and connect to two main oil switches which have overload and reverse current devices. The transformer is of three-phase type, water cooled and wound for a primary voltage of 22,000 and secondary voltage 224 at no load and 220 at full load. The rise in temperature is 40 deg. Fah. at 4000 kilovolt-ampères and 50 deg. at 5000 kilovolt-ampères. There are two secondary coils.

The conductors which carry current to the electrodes are of three kinds:—(a) Twelve copper tubes, making four per phase—see Fig. 4—each 3in. diameter and 40ft. long, which extend through the wall between the transformer house and the furnace room; (b) forty-eight flexible cables in three groups of sixteen; each connected at one end to the above copper tubes and at the other to tubes attached to the electrode holder—see Fig. 5; (c) six copper tubes 5in. diameter and 8ft. long; two are connected to each electrode holder and they carry cooling water as well as electric current—see Fig. 6.

The electrical phenomenon known as "skin effect" is an important consideration when deciding upon the section and arrangements for conductors for such enormous currents as 10,000 to 12,000 ampères per phase, especially when at such a frequency as 60 cycles per second. The conductors have not only to be of considerable cross section, but must be divided up to

FIG. 6—FLEXIBLE CABLES AND ELECTRODE HOLDERS

give large surface. The usual way is to build up each phase conductor of flat strips of copper, but after investigation the designers decided on copper tubes, partly because of the simple rugged construction and partly because calculations showed that the tubes gave lower voltage drop and lower line loss.

The conductors are of such a thickness that the current density is about 800 ampères per square inch when carrying 12,000 ampères per phase. The tubes are spaced at 7in. centres and the tubes of each phase are interlaced with those of the other phases; also the flexibles are interlaced. It is arranged that when the furnace is working normally with nearly unity power factor and the phases in balance, the reactance voltage drop is very low. At the same time, if there should be sudden overload, as in case of a short circuit and unbalancing of phases, then the power factor drops automatically and the reactance voltage is so increased as to protect the plant automatically.

The flexible cables—see Fig. 5—which connect from the 3in. bus-bar tubes to the 5in. tubes of the holders have asbestos cores and are of such a section as to give a current density of 800 ampères per square inch. They are kept 2in. apart by slate slabs which have holes drilled in them for the cables to pass through. The drop in potential from transformer terminal to electrode holder, a distance of 50ft., is only 3 volts. The power factor indicator usually shows the astonishingly good figure of 0.98, whilst the overall efficiency, including transformer losses, works out at 98.5 per cent.

A usual charge consists of the Peruvian ore, slag from previous runs, carbon and certain fluxes. All the materials are ground to a fine powder and thoroughly mixed together, and the mixture is fed into the furnace by screw conveyors. It falls through openings in the roof between the electrodes and is fed in continuously.

When the writer was at Bridgeville, slag left from the aluminium thermic process and from the works of the Primos Company, of Philadelphia, was being used up. It contained 1 to 3 per cent. of vanadium, and the efficiency of the electric furnace process is such that about 80 per cent. of the vanadium is recovered.

The gases from the furnace are carried off by two ducts, each 2ft. diameter, which lead from the top of the furnace to a high chimney. In a charge of 10 tons only 2 tons are tapped in slag and metal.

Ferro-vanadium contains 35 to 50 per cent. of vanadium, the following being an analysis of a good sample:—

	Per cent.
Vanadium	40.20
Silicon	0.72
Carbon	0.55
Aluminium	0.31
Manganese	0.32
Sulphur	0.15
Nickel	0.10
Phosphorus	Trace

The price is quoted at per pound of contained vanadium, which must always be above 35 per cent. Before the war it was about 10s. per pound and at the end of the war 18s. Since then it has fluctuated a great deal; thus in 1920 the price varied from 30s. to 70s., and in 1921 from 20s. to 32s. 6d. It is much used for making tool steel and for the steel framing of motor cars and trucks.

Links in the History of the Locomotive.

By E. A. FORWARD.

No. I.

MARC SEGUIN AND THE MULTITUBULAR BOILER.

Marc Seguin, or Seguin *aîné*, is known to students of locomotive history as a claimant to the honour of having first invented the multitubular—fire-tube—boiler, and applied it to the locomotive, or, rather, as one for whom that claim was made by his native contemporaries. Seguin, who was a clever and able engineer, undoubtedly invented a tubular boiler and afterwards applied it to his own locomotives, apparently without knowledge of earlier inventions or of what was being done in England in the same direction, and it is the purpose of the present article to illustrate and describe exactly what he did, and to show from contemporary records that his claim to priority, in either respect, has no foundation in fact. It will be desirable, however, before dealing with Seguin's work to give a *résumé* of what has been said on the subject.

Edward Biot, who was associated with the Seguin brothers in the construction of the St. Etienne-Lyon Railway, was perhaps the first to advance this claim—in his "Manuel de Chemin de Fer," published in 1834—but his statements were evidently based solely on Seguin's patent of February, 1828, and he was ignorant of earlier patents, both in France and England. Pambour, in his famous work on the locomotive, published in 1835, repeated the claim on the same basis, and pointed out that the boiler of the Rocket had the same form as shown in Seguin's patent drawing. Other French writers made similar statements, without giving any evidence in support of them, while Lobet, in his "Chemin de Fer en France," of 1845, went further and declared that "as usual, the English have appropriated this invention (and also the steam blast) without giving credit to the ingenious Frenchmen who invented them." It may be mentioned, however, that Biot attributed the latter invention to George Stephenson.

The fact that the boiler of the Rocket resembled that shown in Seguin's patent drawing of February 22nd, 1828, has led to some misconception, but the resemblance seems to have been a pure coincidence, as Seguin's drawing could not have been generally known at the time, owing to the fact that the French specifications of the period were not published until the expiry of the patent, in this case in 1838. Lobet's assertion was therefore quite unfounded, unless it is assumed that Seguin himself had communicated it; while if he had done so, it is probable that the Stephensons would have tried the plan sooner, and thus saved themselves much trouble, and possibly rendered the Rainhill trials unnecessary. Seguin's patent drawing of 1828, moreover, is evidently a representation of a stationary boiler, as pointed out by Zerah Colburn, but his locomotive boiler was something quite different, as will be shown. It is a curious fact that not one of the early French writers described or illustrated Seguin's locomotives, or so much as mentioned his second patent of March 25th, 1830, which shows a boiler of the form that he used thereon, although an illustrated report on the engines was made to a local society as early as 1831.

Samuel Smiles, in his Life of George Stephenson (1857), refers to a French author's claims, and to Seguin's patent of 1828, and states that Henry Booth, the secretary of the Liverpool and Manchester Railway, independently invented the tubular boiler. In his Lives of G. and R. Stephenson (1868), Smiles gives Booth's reply to his inquiry on the subject. In this, Booth claims to have invented the boiler and communicated it to George Stephenson when the conditions of the Rainhill trials were published—April 25th, 1829. He averred that he was ignorant of Seguin's proceedings in France, and he was apparently equally ignorant of Barlow's and Neville's earlier patents.

D. K. Clark, in his "Railway Machinery," of 1860, quoted Lobet's statements, and accepted them in their entirety, but Colburn, in his "Locomotives and the Mechanism of Railways," published in 1871, showed that the Englishman, James Neville, had patented the multitubular — fire-tube — boiler on March 14th, 1826, thus traversing the first part of Seguin's claim. He also reproduced Seguin's patent drawing of 1828, but went no further into the matter. Colburn, however, erroneously connected Seguin with the first French railway, that between St. Etienne and Andrézieux, on the Loire, a horse-worked line opened on October 1st, 1828, with which he had nothing whatever to do.

Auguste Perdounet, writing in 1865, asked whether Booth and the Stephensons were aware of Seguin's boiler, but answers the question by remarking that the idea may have occurred simultaneously to two men of genius.

In 1887 the *Illustration des Chemin de Fer* published a rather untrustworthy account of Marc Seguin and his works, in which the old claim was made, with additions. It was there made to appear that Seguin had applied his boiler to a locomotive before he took out his first patent. Another contributor to this account says: "We see, therefore, that the first application of the tubular boiler was not made, as is generally believed, by Stephenson to his locomotive Rocket, which won the prize at the Manchester meeting in October, 1829. Marc Seguin applied it to his steamboats on the Rhone in 1825, next to his locomotives on the St. Etienne and Lyon Railway in 1827, even before having taken out his patent of February 22nd, 1828." Evidence in support of these statements was apparently considered unnecessary. Parts of Seguin's own book are quoted, but other parts which would have disproved the above statements are ignored.

In 1902, in connection with the Paris Exhibition of 1900, Emile Eude published a collection of historical documents relating to eminent French engineers, of whom Seguin was one. The author, with great labour, shows that Seguin took out his first patent before Booth and Stephenson made the Rocket, which is, of course, obvious; but he goes on to say that Seguin's patent showed a fixed boiler, and that Booth and Stephenson were undoubtedly the first to apply the tubular boiler to the locomotive. He then further demolishes the case for Seguin by showing that an American named Barlow had taken out a French patent for tubular boilers, both fire-tube and water-tube, as early as 1793. This writer, moreover, clears up a very important misprint in Seguin's book, when he shows that the applications for his patents were made some months prior to the dates when they were actually granted. He is also the first to mention the second patent of 1830.

For the early history of the St. Etienne–Lyon Railway we are indebted to the interesting little volume, "Hommes et Choses du P.L.M.," published by the P.L.M. Company in 1910, but little accurate information is to be found in the works of other French writers on railways or locomotives. The account and illustrations of Seguin's locomotive are taken from a report on his new system of boiler by Messrs. Albert Schlumberger and Emile Koechlin, read at a meeting of the Société Industrielle de Mulhausen, on October 26th, 1831, and published in its "Bulletin" in the following year. Much valuable information, however, is given in Marc Seguin's own book, "De l'influence des Chemin de Fer, etc.," published in 1839. This work deals largely with railway construction, and has some chapters on locomotives; but while the author explains the functions of his boilers and the alterations he made in the English engines, he gives very little description and no drawings of his own engines. He does, however, give an interesting list of the engine parts and their detailed costs.

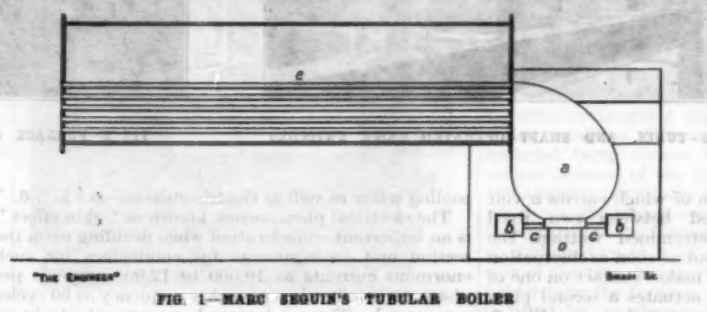


FIG. 1—MARC SEGUIN'S TUBULAR BOILER

a. Furnace fed by a fan or otherwise. b. Air chambers. c. Pipes leading the air to the fire-grate. e. Heating tubes. o. Grate.

Marc Seguin, civil engineer and manufacturer, was born at Annonay in Ardèche, on April 20th, 1786, and died at the same place on February 24th, 1875. He was the eldest of five brothers forming the firm of Seguin Freres of Annonay, and, in conjunction with M. Edward Biot, originated and constructed the St. Etienne–Lyon Railway, for which the Royal Ordinance was obtained on June 7th, 1826. The line was to be the means of realising the long desired project of joining the Loire with the Rhone, which it did in conjunction with the St. Etienne–Andrézieux line. It was 58 kilomts. long, but in that short distance it met with all the obstacles possible to a railway, there being 4 kilomts. of tunnels and no less than 130 bridges. The line was designed so that locomotives could be used throughout, the traffic consisting largely of coal. Marc Seguin attended to the material and traction; Biot surveyed and laid out the line; while Seguin's brothers managed the administrative and financial part of the work. Construction was begun in September, 1826, and in October, 1827, several of the easier portions, to the extent of 10 kilomts., were finished. The middle section of 16 kilomts. was opened in October, 1830, but, owing to the numerous difficulties, it was not until December 15th, 1832, that Messrs. Seguin and Biot announced the completion of the line, which was opened throughout in April, 1833. The traffic was worked by horses and locomotives, there being, in 1834, only six of the latter at work hauling coal. It was not until 1844 that horses were definitely dispensed with.

Seguin appears to have visited England before he began the St. Etienne Railway, and to have seen the Stockton and Darlington and other lines. In the first chapter of his book he says of them: "The Darlington engines were very heavy and were so imperfect that they could only produce steam enough to give a speed of 4 or 5 miles an hour; such a speed, if it had been inevitable, would have considerably reduced the utility of railways. I had foreseen the possibility of perfecting the engines and occupied myself actively towards that end, and had the happiness to invent the tubular boiler, which I gave to the industry in 1827. By the aid of this system one is able to diminish the weight of the machine, to obtain a much greater quantity of steam and consequently more power.

"It was in 1830, when the Liverpool and Manchester Railway began working, that the new boilers were *for the first time* applied to locomotives. They provided immediately a speed far beyond anything that had been thought possible. In the first experiments, made on September 15th, 1830, the speed was carried to 36 miles an hour; in subsequent trials it has been raised to 60 miles an hour, but fear of accidents has made it prudent to restrict the speed to about 30 miles an hour."

We have here Seguin's own unimpeachable statement that, although he claims to have invented the multitubular boiler in 1827, yet he definitely attributes the first application of it to the locomotives on the Liverpool and Manchester Railway in 1830, thus effectually disposing of the latter part of the claim made by his compatriots, who seem to have ignored this statement. Seguin, however, appears to have forgotten the Rainhill trials of a year before, although a copious account of them, extracted from the *Mechanics Magazine*, had appeared in "Annales des Mines" for 1829.

In his introductory chapter he also says: "The success obtained by my new system of tubular boilers, and the immediate application of it which has been made to locomotives, authorises me to hope that I shall obtain results not less satisfactory in the application of it that I propose to make to navigation and to other needs of industry."

In his chapter on locomotives Seguin gives an account of his invention and says: "From the year 1827 I had begun to put into execution the project that I had previously considered of increasing the heating surface by making the hot air provided by the combustion pass through a series of tubes plunged in the water of the boiler. It appeared to me that the non-success of the inverse method of increasing the surface by passing the water through the tubes was principally due to the lack of a sufficiently rapid circulation in the tubes.

"The greatest obstacle that I foresaw to the accomplishment of my project was the difficulty of obtaining in the furnace a current strong enough to cause the products of combustion to traverse the tubes which replaced the flue of the boiler. I feared that their small diameter, while increasing the heating surface, would cause so much resistance to the flow of air as to destroy the draught entirely. It became necessary, therefore, to have recourse to an artificial draught absolutely independent of the chimney. This I obtained by means of centrifugal fans and, after some experiments, I was able to obtain about 2600 lb. of steam per hour with a boiler 9.85ft. long, and 31.5in. diameter, containing 43 tubes of 1.575in. diameter. I then regarded the question as completely solved, and took out a patent for this invention on December 12th, 1837."

This evaporation was very good and was more than double that obtained in the Rocket at the Rainhill trials. The date 1837 was evidently a misprint, for, as shown by Eude, Seguin applied for his first patent on December 12th, 1827, but it was not actually granted until February 22nd, 1828. Pambour said that details of this patent could have been known in England at the time, but Colburn pointed out that the notices of it which appeared contained merely the title of the invention, that in the *Bulletin de la Société d' Encouragement* for 1828 being as follows:—"Steam boiler on the principle in which the hot air circulates in isolated tubes of small dimensions." The specification and drawing are to be found in Brevets d' Invention, Series I., Vol. 37, 1838, Patent No. 3744, being granted for ten years to Seguin and Co., civil engineers and manufacturers, of Annonay.

The specification reads: "For the improved construction of a boiler with hollow tubes.

"The steam being produced by reason of the heating surface, it was thought that a simple and compact arrangement was to make a tubular boiler. Our invention, therefore, as seen in the drawing, is composed of a number, more or less great, of tubes which are traversed by the hot gases, and these tubes, surrounded by water, form a very large heating surface."

It will be seen that the drawing represents a stationary boiler, probably Seguin's experimental one. The barrel is a horizontal cylinder traversed by longitudinal fire-tubes, while the fire-box resembles a cupola, being made of fire-brick and butting against the end of the barrel. The similarity of its general form to the boiler afterwards adopted in the Rocket

undoubtedly led the early French writers to think that the latter's boiler was copied from it.

Towards the end of 1827, the construction of the St. Etienne–Lyon railway was well under way, and, in order to obtain the latest information about locomotives, Marc Seguin, with his brother Charles, paid a visit to England extending from December 9th, 1827, to February 3rd, 1828. They went to Newcastle, and, no doubt, saw the latest engines on the Stockton and Darlington Railway as well. As the result of their visit they, to quote Seguin's own words, "obtained from the French Government authority to introduce into France, free of duty, two engines from the works of the celebrated constructors, Messrs. Robert Stephenson and Co., of Newcastle-on-Tyne, such as were then employed on the Stockton and Darlington Railway. One of these was sent to Monsieur Halete, a distinguished machine constructor of Arras, for him to study, and the other was taken to Lyons to serve as a model for those I was to construct for the service of the railway."

It is known that these engines were being built in 1828, and Robert Stephenson stated that their boilers were fitted with small water tubes in, or across, the flues, but the exact date of their delivery is now uncertain—1829 is most frequently given, and early in that year is probably correct; 1828 is sometimes mentioned, but delivery could hardly have been made until very late in that year, when we consider the capacity of Stephenson's works at the time and the probable date of the order.

Continuing Seguin's account, he says that the results of many tests made on the English engines at Arras and Lyons showed that their steam production did not exceed 660 lb. per hour. They had cylinders 8.67in. diameter by 23.6in. stroke; wheels, 4ft. diameter, and they worked with a steam pressure of 60 lb. per square inch. Their horse-power he calculated at about 10, while their speed was about 3 miles an hour. The evaporation obtained in these tests was, for some reason, very poor, as the Killingworth engines, in 1824, evaporated about 900 lb. per hour, and Nicholas Wood's average figure for the old single-flue engines on the Killingworth and Darlington railways was 1000 lb. per hour. The design of these two Stephenson engines is interesting and peculiar, and unlike any known engines by the same firm. No description of them appears in any English work, and all that was known of them was Robert Stephenson's before-mentioned statement. The earliest description of them appeared in a French article on railways by MM. Coste and Perdonnet, apparently written in 1830; it is as follows:—

"The locomotive which Messrs. Robert Stephenson sent last year to M. Seguin for the St. Etienne–Lyon Railway, resembles, in several points, that at Bolton. The wheels are also of wood with a malleable iron rim, but the boiler is not mounted on springs, and the steam cylinders are vertical and suspended one on each side between the wheels, which are not on on the same axle; they communicate their movement to the axles by a system of levers and rods. The length of the boiler, 10ft.; diameter, 4ft.; thickness of plates, 0.5in.; diameter of cylinders, 9in.; stroke of piston, 2ft. 2in.; diameter of the wheels, 4ft. The weights of the different parts of this machine have been communicated to us by M. Paul Seguin:—

Weight of the boiler with the cylinders and timber work	5644 kgs.
The different pieces, such as rods, &c.	630 ,,
The chimney	181 ,,
Four wooden wheels and two iron axles	1283 ,,
Water	1695 ,,
	9433 ,,

or about 9.5 tons, to which must be added the coal which is on the grate.

The Tender.

The box	410 kgs.
Four wheels and two axles	530 ,,
Cistern	224 ,,
Water	about 1200 ,,
Coal	1200 ,,
= 3.5 tons."	3564 ,,

The cylinder dimensions differ slightly from Seguin's, which were probably more accurate. Seguin himself says of them: "In the Stephenson engines the two cylinders are placed vertically on each side of the boiler. The movement communicated to the pistons by the steam is transmitted to the wheels by means of long connecting-rods, which connect the beam at the end of the piston-rod with pins fixed to the middle of one of the spokes of each wheel."

These English engines did not satisfy Seguin owing to their great weight and low speed, so that he then proceeded to construct a similar engine with a tubular boiler, which was lighter but more powerful. Whether he rebuilt Stephenson's engine, or made an entirely new one, is not certain, but the former is implied by some of his remarks. For producing the draught through the tubes he says: "I employed a centrifugal fan which appeared to me the simplest and surest means of obtaining a current of air as intense as I could desire. I adapted, therefore, to a wagon which carried the coal and water for my first machine, two circular drums, 63in. diameter and 12.6in. wide; the middles of the drums were traversed by axles carrying iron arms, on which were fixed wooden blades. The axles received motion by means of belts driven by pulleys on the wagon axle. I obtained, in this manner, a draught as complete as I could desire, the ashpit pressure by experiment being 0.6in. to 0.79in. of water; that is to say, the draught was equal to that obtained with the highest and best chimneys. This application of the fans had presented, in practice, many very serious difficulties, but they had the happiness, *some time after*, to overcome them by the discovery of a means, simple and ingenious, which consisted of injecting the exhaust steam into the chimney. The activity of combustion procured by either of these two methods is so great that we know of no other limit to the quantity of water evaporated than the extent of the heating surfaces provided."

From this extract it is clear that Seguin knew nothing of the exhaust steam blast until after he had introduced his fan system.

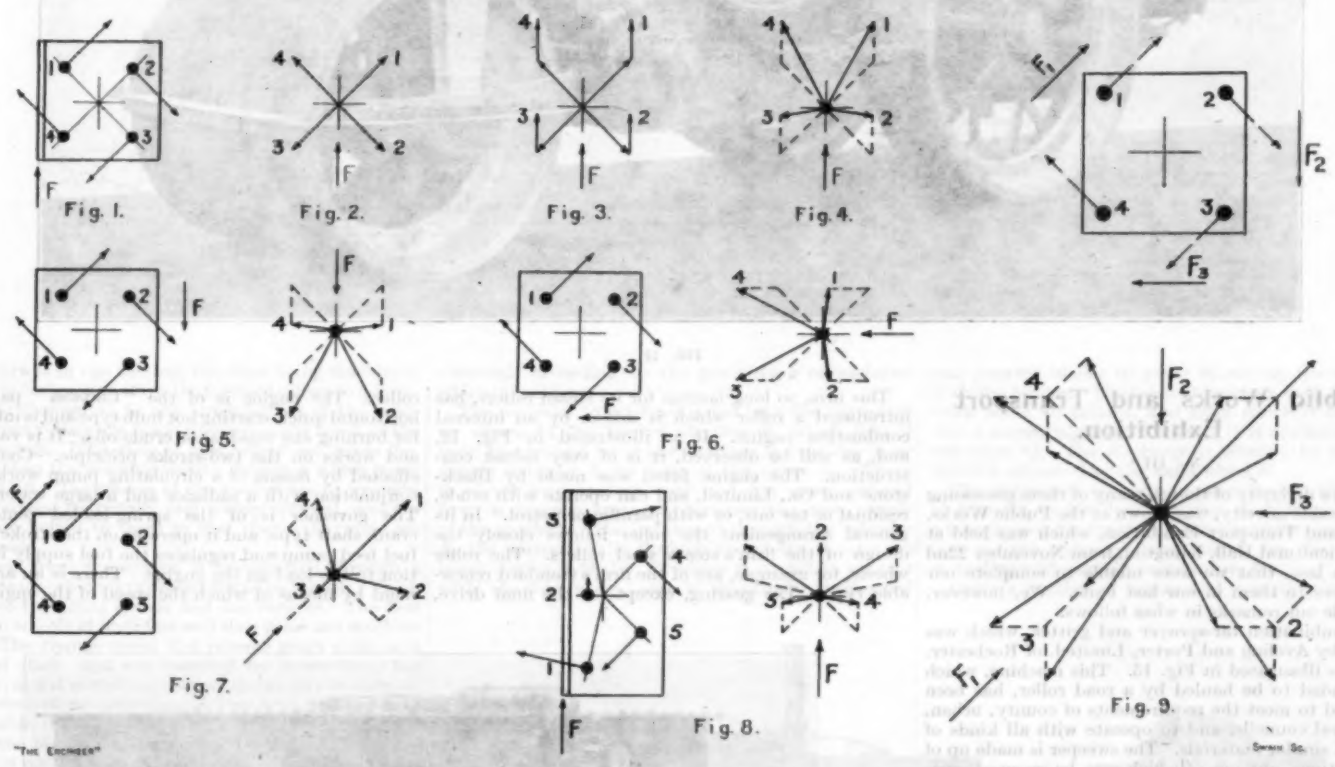
Continuing, Seguin says:—"I made many experiments to determine the best diameter to give to the tubes, with the result that 4 cm. diameter appeared to be most convenient. Independent of the flues and fans I had yet to make many lesser alterations to the first engines which had served as my pattern. I enlarged slightly the diameter of the cylinders to 8.85in., or even in some to 9.06in. I placed between the safety valve and the weight with which it was loaded a spring which prevented it from being opened by the shaking of the engine. I placed strong springs between the body of the machine and the wheels, and at last I adopted all those alterations which were made in England to various parts of the locomotive and which appeared to me to be suitable for those of the St. Etienne Railway."

Polar Diagrams for Riveted Connections.

By J. B. CLARKE.

THE accompanying diagrams illustrate a method of determining by means of a polar diagram the forces acting on the rivets of a connection subjected to an excentric force. In the method outlined, the construction is arranged about a centre point, or the intersection of two axes at right angles to one another, the principal axis being drawn parallel to the line of action of the excentric force applied to the connection. The direction of the moment force for each rivet is first investigated from a sketch of the connection, on which it may be drawn normal to a line passing through the centre of the rivet and the centre of gravity of the rivet group, and acting in the direction in which the excentric force would tend to rotate the connection were it free to revolve about the geometric centre of the rivet group, as in Fig. 1.

The magnitude of the moment force for each rivet may be obtained from the formula Ba_1/I_p, where B = the twisting moment of the connection, or the load multiplied by the excentric arm;



a_1 = the arm of the individual rivet;
I_p = the polar moment of inertia of the rivet group.

The magnitude of the direct force for each rivet is the load divided by the number of rivets forming the rivet group.

The force diagram is constructed by transferring the moment force vectors, in magnitude and direction, from the sketch and arranging them as radial vectors about the origin, or centre point, of the diagram, as in Fig. 2.

Vectors representing the direct forces are drawn, extending from the extremity of the moment vectors and parallel with the principal axis, as in Fig. 3.

The effective force resisted by each rivet is finally represented by a line joining the extremity of the direct force vector with the centre point of the diagram. The result is a polar diagram, in which the resultant forces radiate from the centre, as in Fig. 4. The direction of the excentric force is indicated by an arrow marked F.

In Figs. 5–8 are given diagrams for excentric forces acting in various directions. Fig. 5 illustrates the excentric force acting vertically downwards. Fig. 6 illustrates the excentric force acting horizontally. Fig. 7 illustrates the case in which the excentric force is collinear with the moment force of rivet No. 1. Fig. 8 represents a five-rivet connection. Fig. 9 illustrates the resultant forces on the rivets of a connection—such as a gusset plate connection for diagonal bracing—when the excentric force acts consecutively in three different directions, F_1, F_2 and F_3. It will be observed that the maximum force occurs when the moment force for any rivet acts parallel with the excentric force.

THREE-WHEELED MOTOR ROAD ROLLER

AVELING AND PORTER, LIMITED, ROCHESTER, ENGINEERS

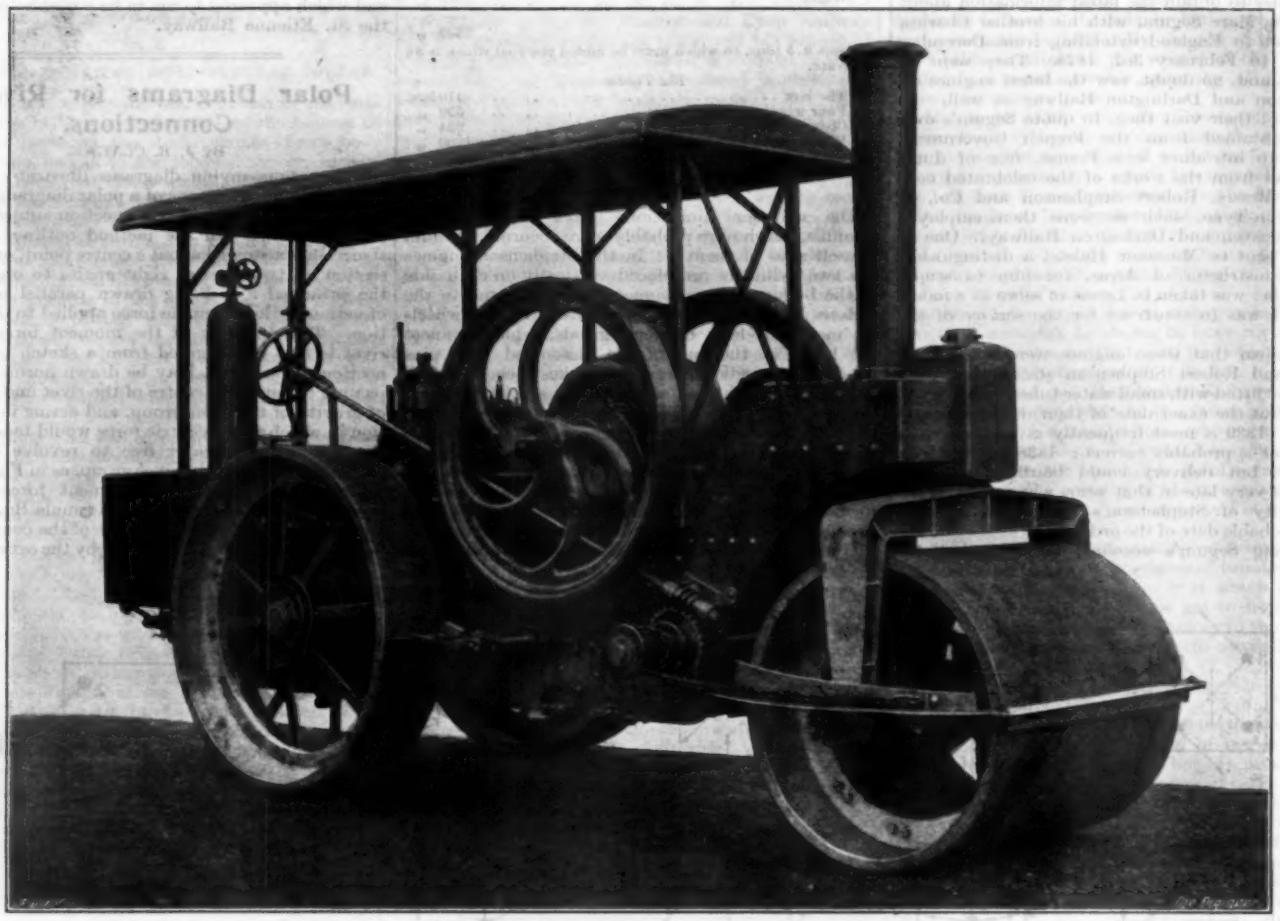


FIG. 12

Public Works and Transport Exhibition.

No. III.*

SUCH a diversity of things, many of them possessing considerable novelty, was shown at the Public Works, Roads and Transport Exhibition, which was held at the Agricultural Hall, Islington, from November 22nd to 29th last, that we were unable to complete our references to them in our last issue. We, however, conclude our remarks in what follows.

A combination tar-sprayer and gritter, which was shown by Aveling and Porter, Limited, of Rochester, Kent, is illustrated in Fig. 13. This machine, which is intended to be hauled by a road roller, has been designed to meet the requirements of county, urban, and rural councils, and to operate with all kinds of tar and similar materials. The sweeper is made up of five sections, any one of which may be renewed separately as required. The tank of the sprayer has a capacity of 270 gallons, and it is fitted with a large steam coil which, the makers state, is capable of heating the charge to any temperature up to 350 deg. Fah. The melted tar is forced through the eight nozzles of the sprayer by a positive acting pump which, it is claimed, can exert a pressure of 200 lb. per square inch at all speeds. The nozzles are divided into pairs, each pair spraying of 1½ft., and one, two, three, or four pairs of nozzles may be operated independently, the material being sprayed being broken up into a very fine spray by centrifugal action. The gritter, which has a capacity of 2½ cubic yards, is furnished with a distributor for agitating the grit. It will cover a width of 6ft.—which is the maximum width sprayed—and is divided into four sections, each section taking charge of one pair of sprays. Any one of the sections can be shut off so as to suit the width sprayed. In action the machine is attached to the draw bar of a steam roller and operates, when the roller is moving forward, brushing, spraying, and gritting at the same time. When the required length of road has been covered the roller pushes the apparatus back over the work and rolls the grit in. This action is made possible by the wheels supporting the apparatus being mounted on castors. The makers explain that, in general, difficulty having been experienced in controlling the amount of tar sprayed per yard of road surface, because the control has been entirely in the hands of the engine driver, they have overcome it by fitting a governor to the roller. The speed is variable to meet any given quantity being sprayed per yard of road surface, and thus the quantity sprayed is determined entirely by the governor controlling the speed of the roller.

* No. II. appeared December 7th.

This firm, so long famous for its steam rollers, has introduced a roller which is driven by an internal combustion engine. It is illustrated in Fig. 12, and, as will be observed, it is of very robust construction. The engine fitted was made by Blackstone and Co., Limited, and can operate with crude, residual or tar oils, or with paraffin or petrol. In its general arrangement the roller follows closely the design of the firm's steam steel rollers. The roller wheels, for example, are of the firm's standard renewable type. The gearing, except for the final drive, is machined from solid steel blanks, while the clutch is of the toggle type and is fitted with easily adjustable wood shoes.

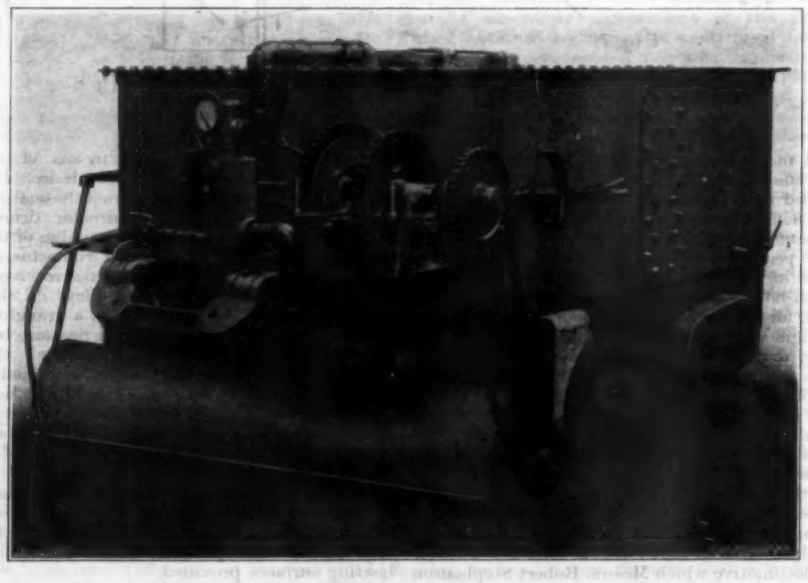


FIG. 13—AVELING AND PORTER COMBINATION TAR-SPRAYER AND GRITTER

A novelty on the stand of Clayton and Shuttleworth, Limited, of Lincoln, was a road roller driven by a crude oil engine. The roller is made in five sizes, 6, 8, 10, 12, and 15 tons, and the example shown, which is illustrated on page 644, certainly had a very workmanlike appearance. As will be observed, it resembles in design very closely the ordinary steam roller. The engine is of the "Clayton" patented horizontal quick-starting hot bulb type and is intended for burning any residual or crude oils. It is valveless and works on the two-stroke principle. Cooling is effected by means of a circulating pump working in conjunction with a radiator and a large water tank. The governor is of the spring-loaded centrifugal crank shaft type, and it operates on the stroke of the fuel feed pump and regulates the fuel supply in relation to the load on the engine. There is an arrangement by means of which the speed of the engine can be varied while it is at work. The fly-wheel is turned on the rim so that it can be used for a belt drive.

The frame is built up of steel girders and channel sections, and is stayed together by channel sections. The side members run the full length of the roller, the whole arrangement evidently possessing considerable strength and rigidity. The frame at the rear end carries the tender, which is made of such a size that the driver can operate the various controls and work the roller in comfort. The tender also carries

the fuel tank, which is of sufficient capacity for two days' working, and also an air bottle, which is charged from the engine, the compressed air, of course, being used for starting. The cooling water tank is fixed under the frame at the rear end. The makers state that it only needs replenishing every two days. Fixed to the back of the frame is a strong steel drawbar lug for haulage purposes, while the silencer casing is riveted to the frame at the front. The casing also forms a bracket for the attachment of the roller head and has riveted to it a massive steel ring to which the roller head, which is of cast iron, is bolted. The roller head fork is in one casting, the stem being machined, and it is designed to allow the forward rollers to accommodate themselves to any irregularities of the road. The front rollers are made to overlap the track of the rear rollers. The rims of the rollers are made 3in. wider than the working width, the extra width being turned off. The spokes of the spiders are of wrought iron, crossed diagonally and widely splayed, and the rims are bolted to them so that they—the rims—are renewable.

Power from the engine is transmitted through a cone clutch which is operated from the tender. There are two travelling speeds and one reverse. The first motion wheels of both fast and slow gears are machine cut. The change speed and reverse gears slide on a splined shaft, and are operated by levers from the tender, and it is claimed that, under no circumstances, can interlocking take place. Two brakes fitted with renewable blocks are provided. One of them, which is on the hind axle, is actuated by a fly-wheel. The other is on the second countershaft and is actuated by a lever. Either brake is said to be capable of effectively holding the roller on steep gradients.

Road rollers were also shown by Thomas Green and Son, Limited, of Leeds; Sir W. G. Armstrong, Whitworth and Co., Limited; Robey and Co., Limited; Builders and Contractors Plant, Limited; Millars' Timber and Trading Company, Limited; and Wallis and Steevens, Limited, of Basingstoke. The "Advance" roller of the last-mentioned firm possesses a number of interesting features. It weighs 6 tons and is claimed to be equally suitable for the consolidation of ordinary granite, tar-macadam or plastic surfacing materials. It is of the three-wheeled type and the rear rolls can, by means of a patented rear axle mounting, automatically adjust themselves to the surface of the road, whether it be flat or cambered. It is a steam roller and the boiler is of the locomotive type. There are two equal diameter cylinders fitted with piston valves and the direction of travel can be instantaneously reversed, so that "dwell" is reduced to a minimum. A two-speed gear is provided and the transmission throughout is by means of spur gears, which are all machine cut, enclosed and automatically lubricated. Steering is effected by worm and quadrant, chains being entirely dispensed with. The brake, which is screw operated, acts directly on the insides of the rims of both rear rolls, the shoes being fitted with renewable facings. Among the accessories which we noted were a steam water lifter, water spraying arrangements for all three wheels, and a steam cock for heating road-making materials.

A multiple drying and mixing plant for stone, slag and similar material, with an output of some 100 tons per day, was exhibited on the stand of Frederick Parker, of Viaduct Works, Leicester. It is illustrated in Figs. 14 and 15. The drying of the material is done in two cylinders, A and B, which revolve in an outer cylinder which, in turn, is carried on two outer roller paths mounted on friction rollers, the latter being driven by means of longitudinal shafts through the bevel gearing C. The inner cylinders are carried on central shafts, which are furnished with internal supporting spiders, and which protrude through the ends of the larger cylinder and are driven by chains and sprocket wheels from the same shaft which revolves the outer cylinder. The inclination of the inner cylinders can be altered by adjusting the bolts D and E, so as to give slower or more rapid flow of materials according to the percentage of moisture which it contains.

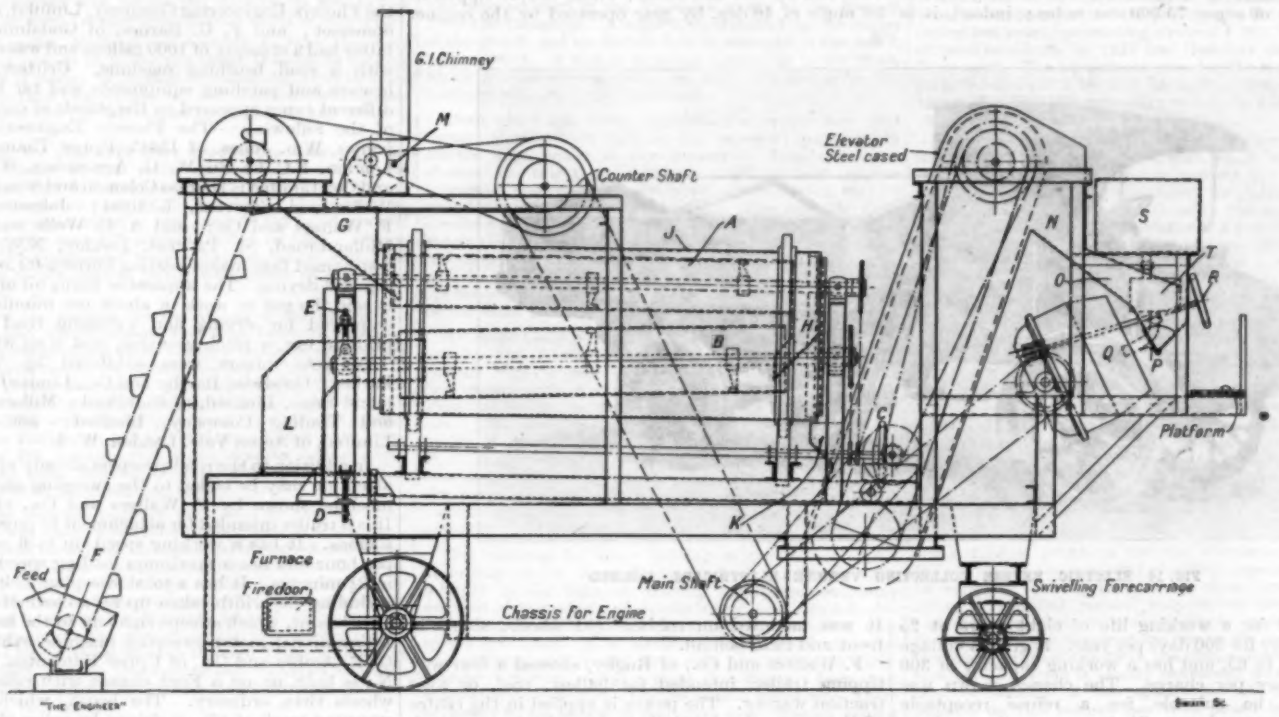


FIG. 14—PARKER MULTIPLE STONE DRYING AND MIXING PLANT

The material to be dried is fed into the apparatus by means of the bucket elevator F, which lifts it from the ground level and delivers it into the inner drying cylinder A by way of the chute G. There it comes into contact with the hot gases derived from a furnace arranged between the rear wheels of the machine. Having passed through the cylinder A, the material falls through the chute H into the lower drying cylinder B, where it is still in contact with the hot gases, and is eventually discharged into the outer cylinder J, along which it passes until it is finally delivered into the chute K. While passing through the cylinder J, the material does not come into actual contact with gases from the furnace, but it is still heated by radiant heat from the inner cylinders, and the makers state that by the time it is discharged into the chute K not only has all the moisture been driven off, but the stone is of sufficiently high temperature to be thoroughly incorporated with the tar or bitumen with which it is to be mixed. The hot gases are drawn from the furnace through the flue pipes L by means of the fan M, and having done their work are discharged to atmosphere through the chimney, which is fitted with a controlling damper.

The heated stone, on leaving the dryer, is lifted by a bucket elevator, which is totally enclosed in a steel casing so as to conserve the heat as much as possible, and is discharged by the chute N into the batch hopper O, which holds sufficient material for one charge and is fitted with a chute P which can be operated at will and which also forms part of the chute for diverting the material into the mixing drum Q. The latter is fitted with internal lifting and pouring blades to assist in mixing the material with the binder. The tar is stored in a tank S, which holds some 80 gallons, and from which it is drawn into a measuring tank T whence it is discharged into the drum Q. The discharge is effected by a worm, which is operated by the hand wheel R.

The apparatus is made in sizes having capacities of from 30 to 300 tons per day, and, if so desired, a trough mixer is fitted as a substitute for, or in addition to, the ordinary drum mixer, for the purpose of dealing with asphalt and clinker, &c.

Quite a number of lorries and wagons of one type and another was exhibited. The Lacre Motor Car Company, Limited, of 78, York-road, King's Cross, London, N.W. 1, showed a 2 to 2½-ton tipping wagon of its O type, fitted with a 30 horse-power engine and the firm's gravity-type tipping gear. The wheels had solid rubber tires, single on the front and twin 870 mm. by 100 mm. on the rear wheels.

We may here say that on the Lacre Company's stand was also a three-wheeled road sweeping machine, which is claimed to possess certain definite advantages that are not obtained with a four-wheeled

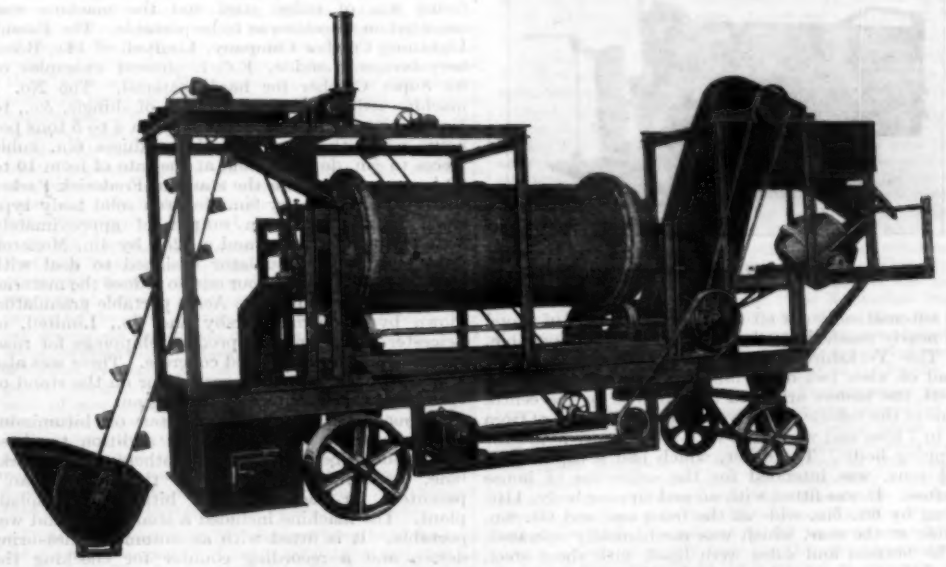


FIG. 15—PARKER STONE DRYING AND MIXING PLANT

chassis. The brush is situated under practically the middle of the chassis, and as the driver sits behind the brush, he has a clear view of its operations and can see what overlap on previous work it is necessary to give, and is not "left guessing," as the company remarks, as he is when he is sitting in front of the brush.

Electricars, Limited, had on view the chassis of an electric refuse-collecting vehicle, fitted with an Edison nickel-iron battery and twin motors driving the rear wheels independently through totally enclosed gears and universal joints. The vehicle gave the impression of being a good sound engineering job, and it is claimed for the battery that it has a life of some 75,000 car miles; indeed, it is guaranteed for a working life of eight years at 25 miles per day for 300 days per year. It gives a voltage of from 78 to 63, and has a working capacity of 300 ampère-hours per charge. The chassis shown was stated to be suitable for a refuse receptacle of 5½ cubic yards, or 2½ tons, capacity, and to be capable of travelling at from 9 to 11 miles per hour. The body to be fitted was to have a power-operated tipping mechanism, which was not, however, in position. A view of a complete vehicle of this type is given in Fig. 16. The same company also showed a little electrically-driven run-about tipping truck, Fig. 17, designed for dealing with road sweepings, boiler-house refuse, coke, &c. It is driven from a small platform, and is fitted with a screw-worked electrically-operated tipping gear, the power for which is automatically cut off when the full extent of travel is nearly reached, so that over-running is impossible.

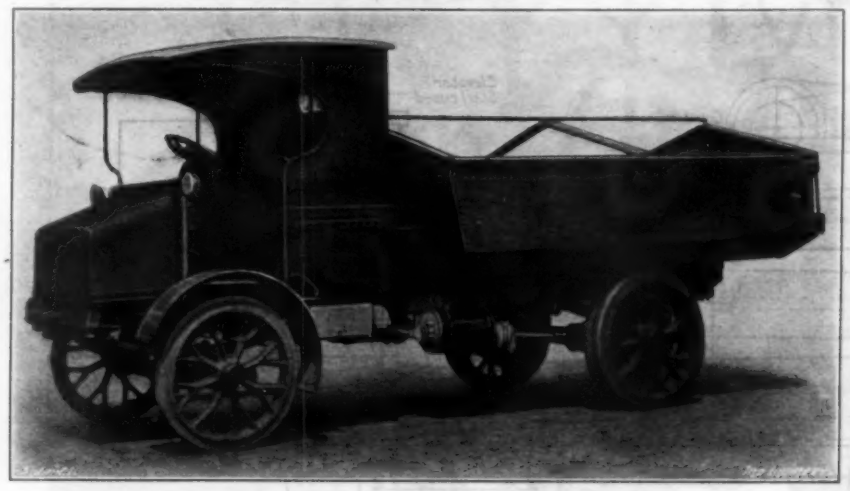


FIG. 16—ELECTRIC REFUSE COLLECTING VEHICLE - ELECTRICARS, LIMITED

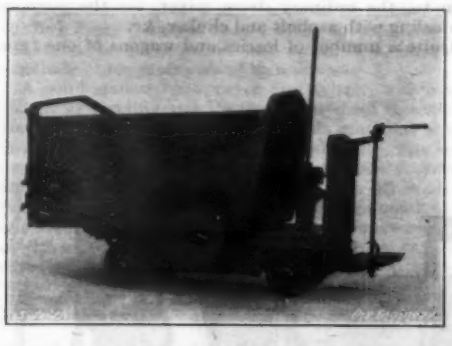


FIG. 17—ELECTRIC RUN-ABOUT TIPPING TRUCK

The Yorkshire Patent Steam Wagon Company had on view two of its familiar type steam wagons, with the boilers arranged athwartwise to the centre line of the vehicle. One wagon had a capacity of from 6 to 7 tons and was fitted with a three-way hydraulic tipping body. The other, which had a capacity of 3½ tons, was intended for the collection of house refuse. It was fitted with an end tipping body, 11ft. long by 6ft. 5in. wide at the front end and 6ft. 8in. wide at the rear, which was mechanically operated. The bottom and sides were lined with sheet steel, and the loading height was only 4ft. 8in.

A 5-ton six-wheeled lorry, specially intended for the transport of road material, sand, gravel, coal, &c., was exhibited by Tuke and Bell, Limited, of 27, Lincoln's Inn-fields, London, W.C. 2. The body had a capacity of 100 cubic feet and was fitted with the "Constable" patented gravity hand-operated end gear and an automatic tail-door. It was driven by a four-cylinder paraffin engine and its speed on the level was given as being 12 miles per hour. The same firm also had on view a 1-ton capacity lorry for the transport of house refuse and general haulage purposes. The vehicle had a hand-operated end tipping body mounted on a Ford chassis. It was mounted on rubber-tired wheels, single in front and twin behind.

Robey and Co., Limited, of Lincoln, showed a 6–7-ton steam wagon with an hydraulically operated end tipping body, for which it is claimed that it is the fastest and most economical vehicle of its type on the road. It is capable, so it is stated, of carrying its full rated load at far beyond the legal maximum of 12 miles per hour, and, in addition, of hauling with ease a 4-ton trailer. The engine is totally enclosed and there is a three-speed gear giving 3, 6, and 12 miles per hour.

An exceedingly neat 5-ton compound steam wagon was shown by Wm. Foster and Co., Limited, of Lincoln. It has a wood end tipping body measuring 10ft. 2in. by 6ft. 6in. inside, which can be tipped to an angle of 40 deg. by gear operated by the engine.

F. Walters and Co., of Rugby, showed a four-way tipping trailer, intended for ballast, coal, or road traction wagons. The power is applied in the centre of the wagon by hand through a short screw jack which rocks upon the frame in any one of four directions. The wagon is supported upon four rocking points, two of which are released when it is desired to tip. This firm also exhibited a refuse collecting tipping wagon which was fitted with its rack tipping gear designed to give an angle of tip of 53 deg.

Of stone crushing machines there were not so many as might have been expected. H. R. Marsden, Limited, of Soho Foundry, Leeds, showed one of their latest model Blake-Marsden X type lever motion stone breakers with a mouth measuring 20in. by 12in. It did not present any features to differentiate it specially from the machines of a similar type which this firm has made successfully for so many years now. Robey and Co., Limited, exhibited a stone breaker with a mouth measuring 12in. by 8in. The frame was of rolled steel and the machine was mounted on wheels so as to be portable. The Patent Lightning Crusher Company, Limited, of 14A, Rosebery-avenue, London, E.C. 1, showed examples of its Super Crusher for hard material. The No. 1 machine reduces 3in. cubic pieces of shingle, &c., to ¾in. down to sand at the rate of from 4 to 5 tons per hour, while the No. 2 crusher reduces 6in. cubic pieces to ¾in. down to sand at the rate of from 10 to 20 tons per hour. On the stand of Frederick Parker there were a 16in. by 9in. Monarch solid body type stone breaker with an output of approximately 8 to 11 tons per hour, and a 12in. by 4in. Monarch solid body type granulator designed to deal with from 2½ to 3½ tons per hour and to reduce the material treated down to ¾in. The Acme portable granulator, shown by Goodwin, Barsby and Co., Limited, of Leicester, is designed to produce chippings for road spraying and for reinforced concrete. There was also a model of a crusher and granulator on the stand of Wake and Co., Limited, of Darlington.

Of machines for producing tar or bituminous macadam there were several in addition to those already described. Johnston Brothers, of 79, Mark-lane, London, E.C. 3, showed their "Bodman" patented tar-macadam and bituminous asphalt plant. The machine included a stone dryer and was portable. It is fitted with an automatic measuring device and a recording counter for checking the amount of work done. It can produce tar-macadam, bitumen macadam or bituminous asphalt carpeting and requires three men to operate it. Sir W. G. Armstrong, Whitworth and Co., Limited, of Openshaw, Manchester, had on view one of their Type A portable drying and mixing plants for tar-macadam and asphalt, which is designed for an output of from 30 to 40 tons per day. The stone drying and tar-macadam mixing plant exhibited by Goodwin, Barsby and Co. included the firm's patented Pyrus cylindrical dryer, which is furnished with a dust removing device, double heat application arrangements, variable speed driving gear, and means for measuring the charges of both stone and tar. A portable dryer and mixer, intended for bituminous asphalt and tar-macadam, was shown by Thomas Coleman and Sons, Limited, of Alfreton, Derby. It was driven by a petrol engine and had an output of from 20 to 30 tons per day. A large-sized model of a scroll dryer and cube mixer for the manufacture of tarred and bituminised macadam was shown by Wake and Co., Limited, of Darlington. Mixers were also exhibited by David Rolls and Sons, Limited, of Sandshill-lane, Liverpool; Builders and Contractors Plant, Limited, of 51, Tothill-street, Westminster, S.W. 1, and Millars' Timber and Trading Company, Limited.

Tar-sprayers and heaters of various types were shown by W. Weeks and Son, Limited, of Maidstone; the Phœnix Engineering Company, Limited, of Chard, Somerset; and F. G. Barnes, of Godalming. The latter had a capacity of 1000 gallons and was combined with a road brushing machine. Gritters, surface heaters and patching equipments and tar boilers of different types appeared on the stands of one or other of the following:—The Phœnix Engineering Company; Wm. Jones, of 154/5, Upper Thames-street, London, E.C. 4; Sir W. G. Armstrong, Whitworth and Co., Limited; Thomas Coleman and Son, Limited; Wallis and Steevens, Limited; Johnston Bros.; F. Walters and Co.; and A. C. Wells and Co., of Midland-road, St. Pancras, London, N.W. 1. The last-named firm makes heating burners for road heating and drying. The apparatus burns oil and can, it is said, be got to work in about ten minutes. It is employed for drying and softening road surfaces prior to tar or pitch grouting, and is on wheels.

Concrete mixers were exhibited by Frederick Parker; Goodwin, Barsby and Co., Limited; Drummond Bros., Limited, of Guildford; Millars' Timber and Trading Company, Limited; and Gaston, Limited, of Acton Vale, London, W. 3.

In addition to the road sweepers already mentioned, attention may be called to the sweeping and loading machine shown by F. Walters and Co., of Rugby. It is a trailer intended for attachment to power-driven wagons. It has a working speed up to 6 or 7 miles per hour and has a maximum loading speed of 1 ton in 2½ minutes. It has a total sweeping width of 7ft., including the width taken up by a channel sweeping attachment, which sweeps right up to the kerb. The International motor sweeping machine exhibited by G. R. Archer and Co., of Upper Edmonton, London, N., is built up on a Ford chassis with rather larger wheels than ordinary. The brush, which gives a sweeping track of 6ft., is driven by roller chains and steel pinions from the worm spindle of the differential gear. The brush is 24in. in diameter and 7ft. 3in. long. It is suspended below the chassis by means of two spring bolts, and its speed synchronises with the speed of the road wheels, the most efficient results being obtained at 8 miles per hour. There are two levers for controlling the brush, one for the lifting and lowering action and the other for adjustment to the surface of the road.

Of miscellaneous exhibits there was a great variety, and it would be quite impossible for us to refer to more than just a few of them. Two displays of water meters are, however, certainly worthy of mention. They were those of George Kent, Limited, of 199/201, High Holborn, London, W.C. 1, and Beck and Co., Limited. The former was a most extensive display, and there were on the stand numerous examples of other measuring instruments, all of them most beautifully made. Then we saw some extremely handy woodworking tools, especially the Dominion 1923 spindle moulder, on the stand of the Dominion Machinery Company, Limited, of Halifax, Yorks. Air compressors, in addition to those already alluded to, were shown by the Ingersoll-Rand Company, Limited, of 165, Queen Victoria-street, London, E.C. 4; and the Engineering and Light Railway Supplies Company, of 244, Abbey House, Victoria-street, London, S.W. 1. Tuke and Bell, Limited, showed an 8in.-bore column of a Carlton revolving sewage distributor of the four-arm type, suitable for filter beds up to 100ft. in diameter. The Ames Crosta Sanitary Engineering Company, Limited, of 12, Victoria-street, Nottingham, had in operation a small-sized model of its "Simplex" sewage purification plant on the surface aeration system. C. Isler and Co., Limited, had brought together an exceedingly interesting exhibit of well boring and drilling plant on the percussion and rotary systems. Finally, mention may be made of the tamping machines shown by B. Johnson and Son, of Ilkley. These clever machines are intended for the ramming solid of the refilling of sewer and other trenches, and also for breaking up macadam surfaces and old concrete up to 15in. thick. There were two sizes of machine, the larger for trenches up to 4ft. wide and the smaller for 2ft. trenches. The machines, which are power worked, consist of a long pivoted arm which can be swung about at desire and are evidently quite easily controlled, and which have at their far end a vertically reciprocating member which is continually being raised and allowed to drop and the bottom of which does the tamping. The raising and lowering of the reciprocating member or tamping bar is effected by the revolution of a pulley or flat-faced wheel, part of the rim of which is cut away. The friction between the intact portion of the face of the pulley and one side of the tamping bar serves to raise the latter, but it drops immediately the pulley has revolved to such an extent that the cut-away portion faces the bar.

Railway Matters.

IT is reported that the turbo-condensing locomotive invented by M. Ljungstrom, is now running on regular express traffic between Stockholm and Hallsberg.

THE New York correspondent of *The Times*, cabling on the 5th instant, reports a trial by the General Electric Company of an electric locomotive for the Paris-Orleans Railway, in which a speed of 105 miles per hour was obtained.

THE general manager of the Southern Railway has informed a deputation from Brighton Corporation that the company would have to complete the electrification of its suburban area before the question of electrifying the line between London and Brighton could be considered.

THE London, Midland and Scottish Railway Company is seeking powers to follow the Great Western in making advances of money to the staff to enable the latter to build houses for their own occupation, and to enable the company to promote the formation and extension of any housing trust.

DURING the year 1922 there were on the railways of the United States 21,592 train accidents, in which 106 passengers and 253 servants were killed. These figures may be compared with 21,251 accidents, 110 passengers and 195 servants killed in 1921, and 36,313 accidents and 95 passengers and 422 servants killed in 1920. During 1922, 2383 trespassers were killed by trains and 1810 members of the general public were killed at road level crossings.

ONE of the hardest worked trains of the day is the London and North-Eastern 8.53 a.m. Leeds to Glasgow, and the corresponding 4 p.m. Glasgow to Leeds, the vehicles of which run nearly 560 miles each day. The former calls only at York, Newcastle, and Edinburgh. The Leeds engine works through to Newcastle and, with 350 tons, does the 80¼ miles in 93 minutes. For the 124¼ miles thence to Edinburgh 145 minutes are allowed. On Tuesday, the 4th instant, this train, despite falling snow, picked up eight minutes between York and Newcastle, and arrived in Edinburgh on time.

ON the Journal page of our issue of October 26th mention was made of the offer of the Great Western Railway to build three lines through certain agricultural areas, provided the State would contribute towards the cost. It is now announced that two further lines are similarly projected. One is from Bridgwater to Watchet and the other from Lydham's Heath, on the Bishop's Castle branch, to Montgomery. The former would give access to the Minehead line without passing through Taunton, and the latter would join the Shrewsbury and Hereford line with the Cambrian main line without going through Shrewsbury and Welshpool.

THE "Twentieth Century" express of the New York Central ran its westbound trip in four portions on Saturday last. The first section ran into a motor car between Buffalo and Cleveland, but the train, it is said, was going so fast that the driver did not think it worth while stopping to see what damage had been done. The second section stopped, and this brought the third to a stand The driver of the fourth portion, however, ignored the signals that protected the train immediately in front of him, and in the resulting collision at least nine persons were killed. Fog prevailed and, it is suggested, hid the signals. There is no system for signalling during fog and falling snow in the United States.

ALL the railway companies have in their Bills for next session identical clauses authorising the establishment of a railway police force, to permit the arrest and search of persons found on railway property who are suspected of stealing, to prevent and punish trespass and the improper use of railway carriages, to give more effectual provision against throwing stones at trains, to permit the establishment of savings banks, and to authorise the substitution of a card index system for the shareholders' address book. The London, Midland and Scottish desires sanction for the gift to the Wolverton Urban District Council of a piece of land for the erection of a war memorial, and the Great Western seeks authority for its chief officers to sign contracts on behalf of the company.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the ten months ended October 31st last was as follows, the corresponding figures for 1922 and 1921 being added in brackets:—Locomotives, £2,371,255 (£4,287,033, £6,594,963); rails, £2,068,568 (£2,097,561, £2,429,468); carriages, £834,389 (£1,593,057, £1,303,896); wagons, £2,622,210 (£2,841,334, £4,998,259); wheels and axles, £811,720 (£1,032,056, £1,456,632); tires and axles, £536,876 (£356,777, £1,107,752); chairs and metal sleepers, £799,973 (£1,832,704, £1,119,361); miscellaneous permanent way, £979,837 (£1,184,275, £2,242,652); total permanent way, £5,450,467 (£6,657,196, £8,581,597). The tonnage of the rails exported was 230,619 (210,166, 122,702), and of the chairs and metal sleepers 69,618 (128,282, 46,541). Locomotives to the value of £139,975 and rails to the value of £63,418 were shipped during the month of October to India, and rails to the value of £41,055 to South Africa, and of £19,527 to Australia.

THE Belgian Government, states the *Indian and Eastern Engineer*, has decided to support the project of electrifying the Matadi-Leopoldville Railway, one of the most important in the Congo. Traffic is now worked by steam engines, but the rapids and waterfalls of the river may be made to furnish 100,000 horse-power, although 30,000 horse-power will suffice to electrify the railway, and it will thus be possible to do without coal, which hitherto had to be brought from Europe at a heavy cost. In order to provide interest on the increased capital—estimated at 50 million francs—necessary to carry out the work, the volume of goods traffic will have to be from 175,000 tons to 225,000 tons. At present, the traffic amounts to 140,000 tons, which will be increased by that from the Katanga when the line from Bucama to Ibebo is completed. It is estimated that the work of transforming the railway to make it suitable for electrification will take from four to five years. The journey from Matadi to Leopoldville, which now takes two days, will occupy only one day when electrification is completed.

Notes and Memoranda

IT is proposed, according to the *Iron and Coal Trades Review*, to reclaim the Duddon Estuary, near Barrow, by means of an embankment, or bridge, and thus enclose a vast amount of land, enabling deposits of ore to be won.

A NEW decree of the Soviet Government declares that the metric system must come into force at once, as far as State institutions are concerned, and that after January 1st, 1927, it will be obligatory throughout Russia.

IN order to help the attendant of a punching machine to locate the work under the tool properly, a neat dodge has been adopted in the American works of the Pressed Steel Car Company. A small hole is drilled up the centre of the punch, and an electric light is arranged in the punch holder above. A spot of light is projected on to the plate, which is manœuvred until the spot coincides with the centre punch dot of the marker-out.

LIME which has been overburned or which has been burned during hydration is the cause of popping in plaster, tests made at the Bureau of Standards have shown. In this type of failure small particles appear to expand and push themselves out of the plaster, leaving tiny holes. In extreme cases these holes may be sufficiently large or numerous to be unsightly. It has been shown that popping will not be serious if the lime is ground fine enough to pass a No. 50 sieve, as in that case the lime will be completely hydrated during the mixing and application, or else the particles of defective lime will be too small to cause noticeable holes.

AN important research on corrosion is being carried out by the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association, the first experimental report on which is to be read before the Faraday Society in London on Monday next, the 17th inst. The work to be described has been carried out by Mr. W. H. J. Vernon under the supervision of Professor H. C. H. Carpenter, F.R.S., at the Royal School of Mines, and deals chiefly with the initial stages of corrosion—the tarnishing of metals. Quantitative measurements have been made on the relative behaviour of different metals and alloys, both indoors and outdoors.

THE material for stone dusting in coal mines ought, according to Dr. J. S. Haldane, to be most carefully selected in the light of existing knowledge, excluding any sort of dust which, when inhaled by itself, has a doubtful record, or is likely to irritate the air passages or eyes by its grittiness. It is fortunate that suitable material is abundant, and is also, as a rule, the easiest to disintegrate into dust. It is evident that dangers from dust inhalation in coal mines require careful watching. There is, however, no reason to fear that stone dusting cannot be applied safely as a preventive of those devastating colliery explosions from which South Wales has suffered so severely.

WRITING to the *American Machinist* on the subject of casting copper, Mr. J. Edgar, of Birkenhead, says that the trouble with copper is that it so readily absorbs oxygen from the atmosphere, resulting in the formation of blowholes and sponginess and of a copper-cupreous oxide eutectic which becomes interposed between the crystals of the metal. These oxide spots are apparent when a casting is broken, and they affect its strength. In regard to pouring temperature, the higher this is the more gases and oxides will be formed. The deoxidiser used is all-important. The surface of the metal must be covered with a thick layer of charcoal to protect it from the atmosphere, but some element must be added to the copper that has a greater affinity for oxides than the copper itself.

IT is suggested in the *Chemical Trade Journal* that the more extensive use of sodium silicate solution for surfacing concrete roads would help the patent fuel makers of South Wales by releasing much tar. The method used in America has been to spray the clean road several times with a very dilute solution, allowing the surface about 24 hours in which to dry between each successive application. What apparently happens is that the hydrated lime liberated during the setting of the cement reacts with the sodium silicate to give a calcium silicate which hardens rapidly and effectively. The result is the formation on the road surface of a hard non-porous layer, not only highly resistant to abrasion and dusting, but also perfectly waterproof.

TO the autumn congress of German chemists at Jena Professor Manchot contributed a paper on the formation of ozone in flames. Parts of the flame which have a temperature of 750 deg. Cent. only contain ozone, as can be proved by the silver reaction. The formation of ozone does not depend on the nature of the combustible gas, ozone being formed with hydrogen, carbon monoxide, methane, acetylene, cyanogen, &c. A flame of oxygen and hydrogen gas of 1300 deg. to 1900 deg. Cent. contains about 0.1 per cent. of ozone, one of acetylene and oxygen of 2100 deg. Cent, about 1 per cent. The latter blackens silver as if it were covered with soot. The thermal formation of ozone, and also the formation from hydrogen peroxide, are not possible, since ozone is also formed within a flame of perfectly dry carbon monoxide. It is probable, it is thought, that the ozone is formed by the action of electrons.

DURING the past year few changes have been made in the general arrangement of motor car lighting and starting equipment. The dynamotor, states *The Automobile Engineer*, has not made very great progress, and in this country is chiefly confined to cars coming within the 11.9 class, the only exception being the new Maudslay. A year ago a number of French makers were fitting dynamotors to very large engines, but there does not now seem to be quite so many of these, although Renault is still retaining the system. The chief objection to the dynamotor from an electrical point of view is that it is desirable to gear it down for starting, while, on the other hand, it should not be run faster than something like crank shaft speed as a dynamo. In practice a direct drive or a gear ratio of the order of 2 to 1 is used, this necessitating a large machine to give sufficient starting torque, or an undesirably high speed when running as a dynamo on some of the modern quick-turning engines.

Miscellanea.

COMPARATIVE tables of coal production show that for the first six months this year, 8,722,205 tons of coal were mined in Canada, valued at 38,188,343 dollars, as compared with 6,205,288 tons for the same period last year, when the output was valued at 26,903,498 dollars. With the better prospects for the supply of power, and with other mines and plants coming into operation, the figures for the complete year are expected to show a very large increase in production and values over last year.

THE number of fatal accidents in American coal mines reported to the Bureau of Mines for the first ten months of 1923 was 2059, representing 3.79 fatalities per million tons, as compared with 1443 fatalities in the corresponding period last year, representing a rate of 4.08. The frequency of fatal accidents in 1923 has therefore declined nearly 7 per cent. The bituminous rate for the same ten-month periods fell from 3.89 to 3.54, a reduction of 9 per cent. The anthracite rate declined from 5.75 to 5.26, a reduction of 8½ per cent.

THE Minister of Health and the Secretary for Scotland have appointed a Committee, with Mr. Edward Shortt as chairman, to inquire into the present law and practice regarding the rating of machinery and plant in England and Scotland respectively; to make recommendations as to alterations which are desirable and practicable, having regard to the considerations involved, with a view to removing inequalities, and, if possible, assimilating the law and practice of the two countries, and to make definite proposals thereon.

A LITTLE evidence of the great change in gearing practice is noticeable in the recent announcement of a new book on patternmaking. The striking part is that no mention is made of patterns for gearing. A few years ago, states the *American Machinist*, no book would have been complete without a substantial section devoted to the making of gear wheel patterns, both spur and bevel. In fact, many of the older books on patternmaking would have been quite small without it. But cast gearing is fast becoming ancient history, and patternmakers now have other problems which demand equal attention.

ELECTRICAL central and sub-stations often present some difficult problems for the ventilation contractor. On account of the nature of electrical apparatus, air must be supplied to keep them cool. Any temperature rise above a specified normal may prove disastrous, and, consequently, the air cooling supply must be certain. Inasmuch as any temperature rise in the machines raises the temperature of the air in the station itself, the ventilation of the station is closely connected with the ventilation or cooling of the apparatus. A comprehensive bulletin on this subject has been issued by a sub-committee of the American National Electric Light Association, and some extracts from this bulletin are given in the *Contract Record* of November 21st.

FIGURES published by the Comité des Forges show that the number of blast-furnaces working in France on November 1st was 116, compared with 111 on October 1st, 77 on April 1st, and 116 on January 1st. The industry is therefore now just where it was at the beginning of the year. The October production of cast iron amounted to 514,230 tons. The production of steel for October showed an increase of 30,216 tons, as compared with September, and exceeded by 62,099 tons the figure for December, 1922. The October total was 476,696 tons. As far as dis-annexed Lorraine is concerned, the production of cast iron—195,100 tons—approached that of January, and the production of steel exceeded by 9623 tons the figure reached in December, 1922. Thus the iron and steel industry in France would appear to have reverted in October to the position it held before the occupation of the Ruhr, steel alone showing an increased production compared with December, 1922.

ACCORDING to our American contemporary, the *Electrical World*, a wireless fog signal has been installed in the new light vessel on Nantucket Shoals, one of the most important lightship stations in the world, as well as one of the most exposed, since it is anchored 41 miles from land. This signal will be operated by an automatic apparatus sending, during fog, a group of four dashes every 30 sec. and thus enabling vessels equipped with radio direction finders to obtain an accurate bearing from a distance of 30 miles, or more, in any weather conditions, and to steer for the lightship. In addition, a powerful electrically operated signal is to be substituted for a submarine bell hitherto employed. This signal will be of 3000 candle-power, and will show at the masthead four occultations a minute. The Nantucket Shoals installation is the eighth wireless fog signal thus far put into commission, and five more are being established in the United States. Ten of the thirteen are on lightships. Nine are on the Atlantic Coast and four on the Pacific.

RECENTLY, Mr. F. Hall asked the Parliamentary Secretary to the Ministry of Transport if he was aware that the Cleethorpes Urban District Council, being faced with the necessity of providing a further supply of electricity, had made proposals for the generating of this supply by means of oil-driven plant as a temporary expedient, pending the termination of an agreement with the local tramway company; that the Urban District Council had shown that this scheme would be more economical than a scheme of supply from the Grimsby Corporation; and that the Department had refused to sanction the Urban District Council's scheme; and whether he would have this matter reconsidered, and arrange for a deputation from the Urban District Council to be received, in order that the question might be fully discussed. Lieut.-Colonel Moore-Brabazon said that the Electricity Commissioners caused a local inquiry to be held into the application, at which evidence was given on behalf of the Grimsby Corporation as to the terms on which that Corporation would be prepared to give a bulk supply. It was not proved, to the satisfaction of the Commissioners, that the establishment of a small generating station by the District Council would, from the point of view of consumers in Cleethorpes, be more economical than taking a supply in bulk, and the Commissioners refused their consent to the application.

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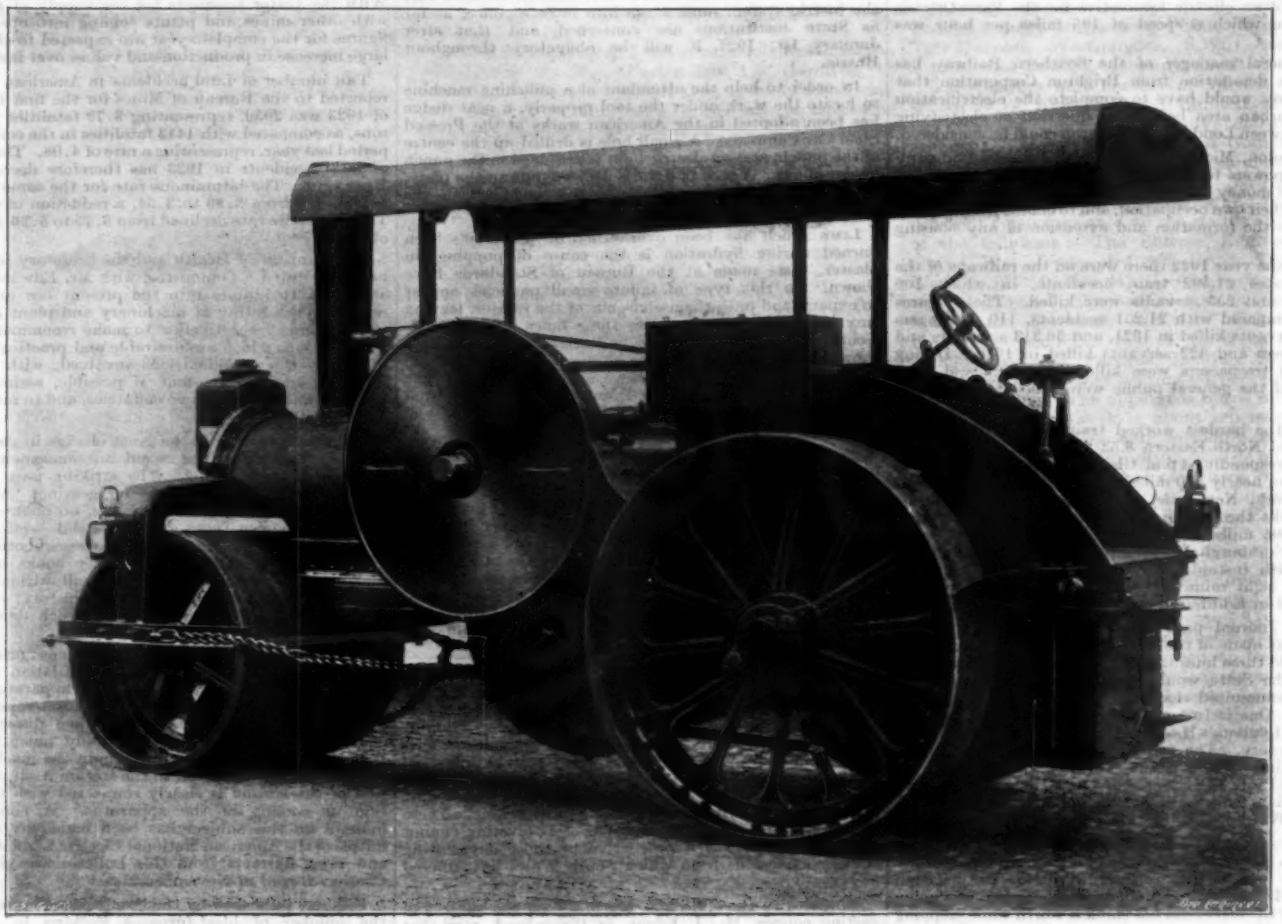

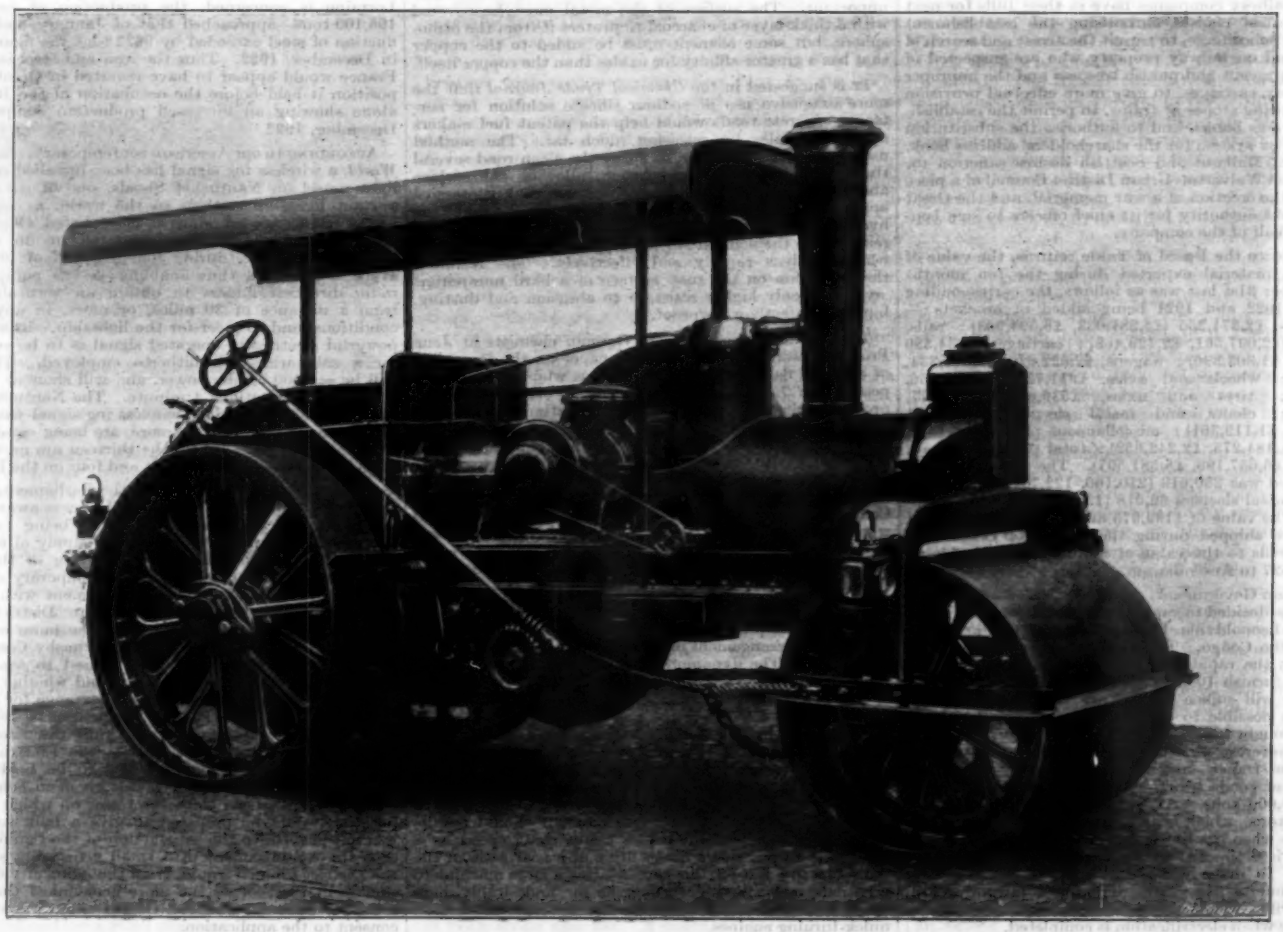

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THE ENGINEER.

DECEMBER 14, 1923.

Fire-box Stays and the Metallurgist.

THE problem of the fire-box stay has been before locomotive engineers for many years, but a completely satisfactory solution has not yet been found. Stays made of tough arsenical copper, although they give good service, to judge from the performances of the many locomotives to which they are fitted, are not without more or less serious faults, and from time to time locomotive men turn to the metallurgist with the demand for something better. In these days of rapid metallurgical progress, such a demand is natural enough, and we may reasonably hope that it will eventually be satisfied. This is one of those numerous cases where the closest co-operation between the engineer and the metallurgist is necessary. It sometimes happens that a change of design is at least as important as the provision of a new material, but the possible variation of design in such a case as a locomotive fire-box are very limited, and although several variations have been tried that radical improvement which is desired has not been attained.

The problem, regarded from the metallurgical standpoint, is by no means a simple one. The actual tensile stress on the stay is not high, the factor of safety being in the neighbourhood of 6 or 7, but the material is exposed to very special conditions. Were it possible to keep the actual deflections due to the breathing and upward expansion of the copper box down sufficiently to allow the material to accommodate itself to them by purely elastic bending, no difficulty should arise from this cause; but, despite many efforts, fire-box designers have not succeeded in eliminating the distortions to which the stays are subjected in service. The best that can be done is to make the stays, particularly those in the upper part of the box, as long as possible. It would appear, then, that relatively large distortions are unavoidable, and the material must therefore be adapted to withstand them. This necessity implies the provision of a metal having a very high degree of ductility, or rather power of enduring slight plastic bendings, for a very great number of times. It is not a question of a high fatigue limit, but of the longest possible endurance under repeated strains, which ultimately are almost certain to produce fracture. This is a form of fatigue testing which has not yet been widely applied. It may, of course, be possible to find an alloy capable of undergoing repeated reversed bendings, producing a small amount of plastic deformation each time, for an indefinite period; more probably we shall have to be content with something that gives, under such conditions, a very long, but not an indefinitely long life. If the stays would last as long as the copper fire-box, enough would obviously have been attained. When this condition has been met, however, there are others equally important to be satisfied. One of the complaints against the existing type of copper stay is that the head, formed by riveting over, "wastes" in the fire until, after a certain time, it becomes too weak to be safely relied upon to hold the stay in place. This appears to be a phenomenon of oxidation dependent upon the chemical properties of the metal, *i.e.*, its readiness to undergo oxidation, and partly upon the temperature which the surface of the stay head can attain. This latter is in turn dependent upon the heat conductivity of the metal used for the stay and upon design—thickness of metal, disposal of the general mass of metal and local water circulation all playing a part. There is also a possibility that the projecting stay heads may suffer from erosion from ashes and from hot gases, which, when moving at a high speed, appear to exert a frictional effect, or at least to carry away minute particles from metal and other surfaces exposed to them. So far as the metallurgist is concerned, these latter difficulties could be met with comparative ease, since hard alloys capable of offering much greater resistance to erosion than copper are well known, while some of them—principally those containing nickel and chromium—are well able to resist oxidation, even at a fairly high temperature. The real difficulty lies in combining in an alloy these rather special properties with the high degree of ductility or toughness which resistance to repeated flexure demands. It is the difficulty of reconciling these divergent demands which has so long delayed the coming of the perfect stay. The difficulty is very considerably increased if we take into account, not only what the material of the stays must withstand when in use, but also the constructional operations which it is called upon to undergo. Since the stays are screwed into the fire-box plates the material must be readily machined with a good screw thread. In extremely tough and ductile materials, machining is difficult, and the demand of the engineer that such screw cutting shall be easy and rapid in itself sets a very real limit upon the range of material available for the exercise of the metallurgist's skill. Furthermore, after being screwed into the plates, the stays must stand being hammered up cold, so as to form a rivet head upon the outer sides of the plates. A metal which is to undergo such treatment satisfactorily must, of necessity, be extremely soft and ductile, and the conditions are made worse when it is demanded that the operation—in the case of any new material proposed for the purpose—shall take no more time or effort than is spent at present upon copper. Whilst copper is most largely used in this country, other metals, as, for example, bronzes, are employed, and in America where steel inner boxes are generally used, iron or steel stays are found suitable. In many respects Lowmoor iron stays leave little to be desired, and those who have had the courage to use them, even in copper boxes, have not been disappointed. Engineers have felt that they had to make the best of the existing materials, and on that account have directed their attention to improvement of design intended, as in the familiar Stone stay, to increase flexibility, or to remove the necessity of riveting, as in the Park stay, which is now but little used. The influence of the design of the box is, indeed, considerable, as is shown by the fact that stay failures occur locally in boxes of particular forms as, for example, in the neighbourhood of the "shoulder." The best practical cure for fracture is to lengthen the stays, particularly those in the upper part of the box, which, obviously, being furthest from the foundation ring, suffer the greatest amount of bending as the inner box expands upwards. With this object in view, tapered boxes, giving a wedge-shaped water space, are sometimes used, and on the Pennsylvania Railroad the stays were at one time lengthened by the addition of a ferrule, which projected an inch or more on the outside of the outer box. The ferrule was coned inside to allow freedom of movement of the stay screwed into it, and, moreover, it was, so to speak, a loose fit in the wrapping plate, so that it could rock as a whole.

A consideration of the combined requirements we have indicated, many of them almost fundamentally contradictory, makes it clear that the problem before the metallurgist is one of very great difficulty. No doubt modern metallurgy can furnish the engineer with material that constitutes

a reasonable compromise, but the engineer is not satisfied with such compromises, since, as a rule, they offer no great advantage over the materials now widely used. The only hopeful course in such a case seems to be really close co-operation between engineer and metallurgist. If the engineer understands the limitations which govern the properties of metals and realises what combinations of properties are possible and what are not, and if the metallurgist, on the other hand, more fully appreciates the needs of the engineer, satisfactory results should follow their common labours. It is obviously impossible to predict or even to suggest the exact direction in which these are to be sought, but one consideration may perhaps be indicated. In many cases where apparently contradictory requirements have to be met, the solution has been found by using a combination of several materials. The coating of sheet steel with tin, in the manufacture of tin-plate, where the steel furnishes a very strong, tough and cheap material, which is rendered suitable for its use by the non-corrodible surface layer of a weak and expensive metal, is a case in point. The application of a hard and durable wearing surface to a steel part in the body of which toughness and ductility are needed, as in the case-hardening process, is another example of the same kind. It seems at least possible that the difficulties connected with fire-box stays might be successfully attacked in some similar way. Clearly, however, this is eminently a case where co-operative research and full-scale trial are needed—needed all the more urgently because of the inherent difficulties of the problem.

The Smithfield Club Show.

The annual Show of the Smithfield Club, which opened at the Agricultural Hall on Monday and closes this, Friday, evening, has nothing to differentiate it from its predecessors. Even the fat live-stock in the centre of the hall appear, to our uninitiated eye, to be remarkably like the beasts shown last year; but on the stands under the gallery where machinery is collected, there is no question as to the lack of novelty. A thorough search round the Exhibition revealed the following items which had not been at the Show before They were:—The addition of a feeding conveyor to a thrashing machine, a change from rubber pads to plain rubber tires on a steam tractor, the substitution of a double-webbed crank for an overhung crank on a force pump, and the staging of a 60 horse-power ploughing outfit in place of a 40 horse-power machine of exactly similar design. On all the other stands the exhibits were precisely similar to those which we have already described in connection with previous shows.

It is probably true, as one of the exhibitors said to us, that agricultural machinery has been developed to such an extent that any change which might be introduced could only be made for the sake of making a change, and not with the object of improving the machine. Another engineer, however, held that the day of the steam engine was passing, for the oil engine was ousting it for agricultural work. He thought, however, that the binary fluid turbine might give steam another lease of life for large fixed plants.

His views with regard to the position of oil engines in agriculture are probably sound. We may mention as an indication of the rapidly growing importance of oil engines, specially the two-stroke solid injection type, that the representatives of several large and well-known firms at the Show told us that the works were being kept going on the production of such engines. Without that business they would be very slack indeed. It was really remarkable how many oil engines were being sold. Discussing the effects of the competition by American makers of small, cheap petrol engines, we found that the British makers of small sets were not greatly concerned by it. Many cheap foreign engines, we were told, are a constant source of worry to the agents who sell them, as they are perpetually in need of repair or overhaul, and the agents find a difficulty in justifying a charge for such work. On the other hand, the more thoroughly constructed British engine, although slightly more costly at the start, is less expensive in the end, and does not need nearly so much nursing. There were, at the Show, various examples of both the British and foreign types of small engine, together with several fairly large English units, and it was instructive to compare the workmanship of the different makes.

It is with regret that we break a long-standing tradition and give no illustrated description of the exhibits. The Smithfield Club was established, as the Smithfield Cattle and Sheep Society, in 1798, and did not adopt its now familiar name till 1802. It was, as its name implies, primarily interested in butchers' meat, and its first Show was held at Smithfield in 1799. By degrees it extended its scope, and in the second volume of The Engineer we find a long list of the machinery exhibited under its direction in the Bazaar, King-street, Baker-street, in December, 1856. From that date onwards we have found annually—one or two of the war years excepted—some new developments in agricultural machinery to deal with. The "Show" has always been an important function of the year from an engineering point of view, for the farmers and stock breeders who collect from all parts of the country to examine the animals come also to place orders for machinery. Moreover, in happier days, it used to be the practice for the foreign agents of some of the greater firms to foregather on these occasions to settle their contracts for the coming year. Well do we recall the dinners given by Ruston, Proctor and Co., as the firm was in those days, and the impression of world-wide ramifications that was given by the foreign agents from all corners of the earth who assembled at them. Let us hope that such entertainments will come back again, and that the hint of better times for agricultural engineers that is conveyed in the fact that this week, for the first time since the war, wheat has arrived in England from Russia may prove true. With the recovery of the Russian and Siberian market for agricultural machinery, the aspect of a large and important section of the engineering trades would be vastly improved, and we might then expect to see the next Show of the Club—the one hundred and forty-fifth—as interesting in all respects as those that have preceded it.

Gas Turbines.

By JULES DESCHAMPS.

I have read with the greatest interest the series of articles on "Gas Turbines" which recently appeared in The Engineer. I do not desire to discuss either the detailed information given nor the very useful calculations presented. My object is only to offer a few observations on the general subject.

The numerous tables which accompany the series show that the efficiency of the gas turbine cannot attain that of the reciprocating gas engine. My opinion is that there are two objections to that conclusion. The first is that, in the theoretical part of these articles, only the case where the gases are not cooled during the exit from the combustion chamber by the injection of water or steam, or by inert gases, is considered. Obviously, while the problem as it stands is already very complex it may be even more so. Exact data is lacking as to what happens in mixtures of steam and burnt gases, and the known formula to which one can refer are open to considerable doubt. Evidently also, the turbine then becomes a form of steam turbine without any boilers in which the burnt gases mix with the steam. Furthermore, the apparatus is more complicated and has not the simplicity of the ideal turbine which would consist only of a turbo-compressor and the turbine itself.

But if this ideal gas turbine with its lightness and small amount of complexity is not realisable in practice, or only so in cases with reduced efficiency, must we altogether abandon the mixed type? Is it not true that even in the reciprocating engine, as, for instance, the Still engine, a similar solution is sought and with excellent results?

This solution with injection of water or steam at the exit from the combustion chamber seems to be imperative with certain combustibles, for otherwise one cannot burn these fuels without a great excess of air, at the high temperature and high pressure which are necessary in order to ensure that the combustion shall be complete and rapid. On the other hand, the theory shows that the *theoretical* efficiency depends above all upon the initial compression, and the *practical* efficiency upon the proportion of work which is required for the compression being small. It is only by compressing the minimum amount of air necessary for the combustion of 1 lb. of oil that one can obtain this result, and then the combustion occurs at very high temperature. Hence it is necessary to cool the gases.

It does not seem to me, at least with the constant pressure turbine, that one can actually do useful work without a mixture of steam, and the figures in the tables can, therefore, be considerably modified and improved. In 1906 I directed attention to the fact that in all engines with initial compression the effort required for the compression corresponded to $+\int v\,dp$, whereas in the piston engine the work of the compression was $-\int p\,dv$. For adiabatic compression the two are in the ratio of γ. This is one of the reasons why the Diesel engine has so high an efficiency, despite the fact that it compresses twice as much air as is necessary for theoretical combustion and 160 per cent. of that which is necessary for combustion in a combustion chamber.

It seems that one might get over this difficulty, at any rate, to a great extent, with piston compressors by, for example, forcing the compressed air into the combustion chamber, not by the action of the piston itself but by an expansion due to the commencement of combustion. It is, in fact, the work of the piston which is required to drive the compressed gases from the compression cylinder into the combustion chamber which represents the difference between $+\int v\,dp$ and $-\int p\,dv$. I do not wish to insist upon this point, preferring to keep only to generalities. I have touched upon it only to show that there are two ways in which one can reduce by one half the work of compression, by reducing this to $-\int p\,dv$ and by reducing the quantity of air compressed to that which is strictly necessary. I should like furthermore to remark that, if the work of compression is reduced to $-\int p\,dv$, adiabatic compression costs considerably less in work than isothermal compression, which is very complicated and which has always been one of the drawbacks to the success of the gas turbine.

There always seem to have been objections to the piston compressor and a desire to see a turbine served by a turbo-compressor. If we reduce, as I have indicated above, the work that is demanded of the compressor by one half, and if we remember that the efficiency of a reciprocating compressor is superior to that of a turbo compressor, and that the technology of it is well understood, I believe that in the present state of our knowledge that type of compressor should be used for the turbines which we wish to study. After all these considerations it does not seem to me that we are bound to look upon the gas turbine as having as restricted an efficiency as that indicated in The Engineer, and, *a priori*, lower than that of a reciprocating engine.

I have so far discussed this subject as is generally done—that is to say, as if the gas turbine should be studied on the same theory as that of the reciprocating gas engine, but there are some important reservations to be made. The gas turbine obviously follows the steam turbine and the gas engine. From many points of view, however, its study must be entirely special to itself, and before systematic experiments have been made, theoretical considerations only might lead us considerably astray and limit our hopes and researches. I will endeavour to make this point rather clearer.

In the steam turbine we have to do with water vapour of which the different coefficients, specific heat, the entropy, the temperature as a function of the pressure, are all well known. Furthermore, the fluid is homogeneous, one might say, that during the whole course of the steam after it leaves the boiler its state is constant at each point of the circuit and well known. It is quite different with a mixture of combustible gases and air, which is not homogeneous and still less so if combustion takes place round little drops of hydro-carbons and if water vapour is introduced. The temperature then may vary considerably in different parts of the same nucleus. I have already shown that to speak of the entropy of such a mixture is a theoretical fallacy—*Chaleur et Industrie*, March, 1923—that to try to evaluate it will give in practice enormous errors, and that to consider a temperature entropy cycle is dangerous in this case. Furthermore, from the chemical point of view particularly, changes in the condition of the working fluid continue to take place right up to the exhaust valve chamber in a gas engine. It is, then, difficult to foresee, without further experiment, what will occur in a gas turbine if we only use the knowledge and data derived from steam turbines.

Let us now consider the comparison with reciprocating gas engines. The apparatus necessary for this study is the indicator. It gives us the mean pressure at each point of the stroke of the piston with ample accuracy. Now, the pressure is the figure which interests us most in the piston engine. Its variations fix the compression and the work done during combustion and expansion. I strongly insisted twenty years ago—*Les grands moteurs à gaz-Théorie des moteurs a gaz*, Dunod, 1901—that for the establishment of the theory of the gas engine it was far better to study the curves of the indicator itself than the theoretical curves which do not correspond well with the former. Work can only be effective on a piston when there is a difference of pressure on its two faces. We very rightly neglect the kinetic energy of the gases. But for the gas turbine it is not the pressure which is the essential factor but the speed and density of the gas which enters the turbine. That is quite a different matter. I shall be told that the velocity of flow depends upon the pressure in the combustion chamber and in the exhaust chamber. This can only be possible if the speed of the gas was nil in the combustion chamber and nil at its exit to exhaust, and even this would not be true because combustion is carried on continuously in the expansion nozzles and because part of the heat is transformed directly into kinetic energy.

The elementary operation to be considered is :—

$$d\,Q = C_v\,d\,T + A\,p\,d\,v + \frac{A}{2g}\,d\,w^2,$$

where w is the speed of the gases. In other words, one heat element gives simultaneously an increase of temperature, an external work of expansion, and an increase of kinetic energy. The last named is neglected in reciprocating engines. It may be negligible in certain types of gas turbine. In others it may form a tangible quantity, as, for example, in the Holzwarth turbine, where the explosion directly imparts velocity to the gases, and this is possibly one of the factors to consider when one is surprised at the value of the efficiency claimed. In any case, for this particular turbine, we may regard the indicator diagram as having little interest. To show that it is not without reason that I raise this objection I will take an example.

The possibility of combustion taking place in the nozzles themselves has already been considered. Take the case of a turbo-blower which only imparts velocity to air without increasing its pressure and imagine that the current of air having thus acquired a velocity equal to W_2 traverses a passage of suitable dimensions into which oil is injected and fired so that the speed of exit W_3 is greater than W_2, while the pressure has remained as before, and imagine that this mixture of gases enters the turbine which reduces the velocity to W_4. If now we attempt to calculate the results obtained by the equations for the conservation of energy, we find that we reach formulæ analogous to those of gas engine practice, the value of the velocity factor replacing that for pressure, but, with this reservation, that experience only can show, as in other matters, what really happens in the slightly divergent nozzles in which combustion would take place. The output, however, would certainly be positive and probably of the same degree of magnitude, whereas the P V diagram would give a zero value and possibly even a negative one. This is a special case besides being an extremely interesting one, for the phenomena which are considered are found in part in all gas turbines. They indicate the considerable mistakes which one can make by considering pressures only. Furthermore, the idea of pressure is a static idea. The pressure in a moving fluid is almost impossible to measure.

My conclusion is that the entire theory of gas turbines needs to be revised. That will only be possible when a great number of experimental results are available with which to check the formulæ which it is proposed to use in future. The greater part of those now employed, notably those for the mixtures of gaseous fluids, lead us to erroneous conclusions and must be modified. It is only systematic research, without preference for this or that method, at least at the beginning, which can indicate the directions in which to proceed, and I am convinced that those who have the actual means of carrying out such studies would advance in front of those who wish to-day to construct a turbine on existing data, and that this advantage would be of considerable magnitude.

Obituary.

SIR THOMAS L. DEVITT.

WIDESPREAD regret is felt, not only in shipping circles, but in many other directions as well, at the death of Sir Thomas Lane Devitt, which occurred in London on Saturday last.

Thomas Lane Devitt was born on March 28th, 1839. He was, therefore, well on in his eighty-fifth year at the time of his death. He was the eldest son of the late Mr. Thomas Henry Devitt, who, in 1836, in association with the late Mr. Joseph Moore, founded the firm of Devitt and Moore, a firm which concerned itself at first with shipbroking, but which, later, became an extensive owner of shipping, including the "Queen of the Thames," the first power-propelled vessel to make the voyage round the Cape to Australia. Thomas Devitt the younger began his career in the firm's office, and he was associated with it during the whole of his business life. He was always a great believer in the sailing ship, and maintained that the best training an officer, destined eventually to hold commands in steamships, could undergo, was that which he would receive in ocean-going sailing vessels, especially those of the square-rigged type. The ships of his firm had for long the reputation of being among the best training schools for officers of the mercantile marine, and Sir Thomas, acting with the first Earl Brassey, devised a special scheme for forwarding this educational work. He it was, too, who founded the Nautical College at Pangbourne for the training of cadets, himself purchasing the necessary land.

As long ago as 1879, Mr. Devitt, as he then was, became a partner in the firm of F. Green and Co., which, among its other activities, managed the Orient Steam Navigation Company, in the affairs of which he took a deep and active interest. In 1886 he was elected an underwriting member of Lloyd's, and thus began an association for which he was as widely known as for the distinguished position he held in his own particular business, and which did not terminate till the end of 1920, when ill-health compelled him to retire. For the last eleven years of his connection with the Register he held the position of chairman, the duties of which he discharged with conspicuous ability.

Considering the calls which the businesses already mentioned must have made on his time and energies, it is wonderful that Sir Thomas should have found opportunity to undertake further responsibilities; yet, as a fact, he filled a multitude of other parts. In 1890 he was elected President of the Chamber of Shipping of the United Kingdom, and chairman of the then recently founded Shipping Federation. The latter position he held until 1914, when he was made President of the body. In 1893–4 he was chairman of the General Shipowners' Society of London, and was, for some years, a member of the Thames Conservancy. In 1893 he was chosen a hospital visitor of the King Edward's Hospital Fund, and in the same year was appointed a governor of St. Thomas' Hospital, becoming a member of the Grand Committee of that institution in 1916 and an almoner of the hospital in 1920. He served on the Advisory Committee of the Board of Trade, and was a member of the London Local Marine Board. He was, at one time, President of the Institute of Marine Engineers, and Master of the Shipwrights' Company in 1917–18, in the latter year, also, serving as President of the Sailors' Home in Wells-street and Dock-street, E. He was also twice Master of the Skinners' Company. He took a very keen interest in the Royal Merchant Seamen's Orphanage at Snaresbrook, of which he, for some time, acted as chairman, and to which, in conjunction with Sir Alfred Yarrow, he, in 1919, presented the Bearwood Estate, near Wokingham, for the purposes of founding an orphanage to replace that at Snaresbrook.

Sir Thomas was created a baronet on the King's birthday in 1916.

Leonardo da Vinci.

AT the last meeting of the Newcomen Society, which was held at Caxton Hall on Thursday, December 6th, Mr. Ivor B. Hart presented a very interesting paper on "The Dynamics of Leonardo da Vinci." Through the courtesy of *Engineering*, advance proofs of a long abstract of the paper were presented to the members, and the author, instead of following his text, adopted the admirable plan of giving a general survey of da Vinci's work in technology. The lecture was illustrated by a number of lantern slides of sketches taken from Leonardo's books. Mr. Hart opened by calling attention to the characteristics of the curious script used by da Vinci. These characteristics he described under four heads:—"First, he wrote from right to left, after the fashion of the Semitic group of languages; second, his handwriting was of the kind known as mirrored, i.e., reversed in a manner as would be produced by looking at a normal script through a mirror; third, he employed an elaborate scheme of abbreviation; and fourth, he omitted the use of punctuation." It was only owing to the patient efforts of workers that the difficulty of transcribing this curious script into ancient Italian, and thence into modern Italian and other modern languages was effected. Passing on, the lecturer dwelt for a few minutes on the wide scope of Leonardo da Vinci's genius, and referring particularly to his scientific work, he noted that Leonardo was the grandfather of experimental philosophy as an appeal to experiments pervades all his writing on scientific subjects, but his ideas and his discoveries outstripped his language. Living and thinking in terms of the late sixteenth and seventeenth centuries, he was yet compelled to express himself in the restricted language of the fifteenth. In such circumstances, vagueness of expression was inevitable, but despite this vagueness it is clear that Leonardo was groping towards the true laws of dynamics, and Mr. Hart observed that he just fell short of the realisation of an important truth which might otherwise have carried him far. In one of his manuscripts he says, in discussing the subject of falling bodies: "Why does not the weight remain in its place? It does not remain because it has no resistance. Where will it move to? It will move towards the centre of the earth; and why by no other line? Because a weight which has no support falls by the shortest line to the lowest point, which is the centre of the world. And why does the weight know how to find it by so short a line? Because it is not independent and does not move about in various directions." He was led by his experimental study of falling bodies to the idea of a uniformly accelerated motion, and in this connection he was, as Mr. Hart was able to show by a diagram on the screen, the originator of the mathematical graph.

The subjects selected by the lecturer from da Vinci's note-books showed the variety of problems with which da Vinci set out to deal, and one could not but be astonished by the mechanical genius he displayed in many of his inventions. We may particularly note the excellence of his designs for cranes and lifting appliances and the ingenious manner in which he employed combinations of gear wheels and screws.

The brief discussion which followed turned mainly upon the question of why da Vinci chose to write in such a cryptic manner, and the interesting question was raised as to whether he was naturally left-handed. To this, Mr. Hart replied that there was little doubt that he was a healthy left-handed youngster, but that his father did all he could to make him right-handed. It was not certain, however, that left-handedness was the cause of his writing from right to left instead of from left to right. Colonel Bellaiew suggested that he possibly followed no more than a foolish fashion that may have been current at the time; but the general feeling of the meeting was that his note-books were merely commonplace books from which he proposed to prepare fair manuscripts at some later date, and that he wrote in a covert style with the intention of maintaining secrecy until such time as he himself chose to reveal his ideas.

SIXTY YEARS AGO.

IN our issue of December 11th, 1863, some notes were given on the mechanical exhibits at the Smithfield Clubs' Show, the second Show to be held at the Agricultural Hall, Islington, then but recently erected. Of the several firms mentioned as showing engines, machines, or implements, quite a considerable proportion will also be found represented in the Hall this week. Garrett, Hornsby, Marshall, Turner, Ransome, Clayton, Howard, Fowler, Aveling—all these names familiar to us to-day are to be found mentioned in our account of the Show of sixty years ago. The novelty of the Exhibition appears to have been a farmers' steam engine, shown by Mr. F. H. Wenham, of London. This engine, of about 10 horse-power, had a 5in. high-pressure—100 lb.—cylinder and an 8½in. low-pressure cylinder. The novelty in its design consisted in the provision of a superheater, whereby the steam was dried after expansion in the first cylinder and before being farther expanded in the second. . . . In a paper read before the Society of Arts, Mr. F. H. Holmes discussed "magneto-electricity" and its application to lighthouse purposes. Mr. Holmes claimed that the "magneto-light" was a purely English invention. Faraday, he said, had laid the foundations for it when he discovered that magnetism might be made to produce or induce an electric current. Although the magneto-light was first produced in Paris, it was he (Mr. Homes) who had done so, and, far from receiving any assistance in the matter from French scientists, he had been ridiculed by all of them for attempting what they said they could demonstrate was impossible. A Holmes' magneto-light equipment had been at work at Dungeness Lighthouse for the previous eighteen months or so. The equipment consisted of two coke-fired Cornish boilers, two direct-acting steam engines, and two magneto machines, each containing 120 horse-shoe magnets of about 50 lb. each and 160 helices of wire. . . . The fate of an old Clyde river steamer, the Windsor Castle, is to be found recorded in a paper, "Steam Navigation on the Indus," read by Mr. Alfred Warren before the Society of Engineers and reprinted in the same issue. This vessel was purchased by the Oriental Inland Steam Navigation Company, and was taken to pieces on the Clyde for shipment to India. The vessel carrying the hull parts, however, "went to the bottom before it had got to sea." The engines arrived safely at their destination and were eventually incorporated in a steamer, the Indus, the hull of which was launched at Kurrachee in 1861. It would appear that the Windsor Castle was not the only Scottish vessel which it was sought to transfer to Indian waters, for we find it recorded that "others of the Clyde steamers, purchased by the company, were lost in their passage out to India."

LIGHT RAIL TRACTION IN SOUTH AFRICA

SOUTH AFRICA, with its small population scattered over vast distances, finds road transport one of its most difficult problems. There are districts rich in agricultural possibilities, but situated far from the main lines of railway, so that the cost of transporting the produce to the nearest rail point is practically prohibitive. The traffic available at present is far too little to render even a light railway an enterprise that would pay. In many cases, were such light railways built, it would lead to more farms being taken up and greatly increased production from those existing, so that in years to come it might become a paying undertaking. Unfortunately, there is a number of non-paying lines already in existence out there, and the Government in these days cannot afford to embark on speculative undertakings, however promising they may appear on paper.

It is for this reason that great interest is being taken in a practical test which will shortly be given to the Stronach-Dutton road-rail system of light rail transport, which was fully described in THE ENGINEER of June 28th, 1918.

The principle of the invention is to haul trains of light trucks running upon the very lightest type of railway track by means of an ordinary road motor vehicle or tractor straddled over the rail track with its driving wheels bearing upon the ground surface on either side; but, owing to their wide spacing, these driving wheels run clear of the rails and sleepers of the narrow-gauge railway track. If an ordinary road tractor is used the front axle of the tractor is lifted on to a small railway guiding truck running on the rails, and the tractor can be readily lowered off this rail truck and utilised for ordinary road work whenever required. The 20-mile test line is being laid down from Naboomspruit, on the Pretoria-Pietersburg line, and a terminus on the farm Ceres, situated in the Springbok Flats, Northern Transvaal. The estimated cost is £753 per mile (second-hand 20 lb. rails), or a total of £20,670, including rolling stock. The rolling stock consists of two steam tractors, twenty trucks, and two passenger vehicles. The probable annual expenditure, including interest at 5 per cent., is placed at £3736, and the earnings at £3760 for the first year, with rapidly increasing profit thereafter.

BOOKS RECEIVED.

The Microscope: Part II., an Advanced Handbook. By Conrad Beck. London: R. and J. Beck, Limited, 68, Cornhill, E.C. 3.

Hydraulics. By E. H. Lewitt. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 8s. 6d. net.

Wireless for the Amateur. By J. Roussel. London: Constable and Co., Limited, 10–12, Orange-street, Leicester-square, W.C. 2. Price 14s. net.

Henry Ford: The Man and his Motives. By William L. Stidger. London: Hodder and Stoughton, Limited, Warwick-square, E.C. 4. Price 2s. 6d. net.

Contribution à la Théorie des Moteurs à Combustion Interne. By M. Brutzkus. Paris: Gauthier-Villars et Cie., 55, Quai des Grands-Augustins. Price 8f.

A WIRELESS VALVE REPAIRING WORKS

REVALCO, LIMITED, LONDON, ENGINEERS

(*For description see opposite page.*)

FIG. 1—OPERATOR OPENING THE BULB OF A VALVE

FIG. 2—FITTING NEW FILAMENT TO VALVE

FIG. 3—EXHAUSTING REPAIRED VALVES

FIG. 4—TESTING REPAIRED VALVES

A Wireless Valve Repairing Works.

THE high cost of wireless receiving valves is, no doubt, a great drawback to the broadcasting section of the wireless industry, and if valves could be sold at a lower price, the manufacturers of receiving sets would experience better business. Unfortunately, valves do not last for ever. After so many hours of work the filament gives out in the same way as the filament of an electric lamp, and a new valve has to be purchased. For some time past, however, it has been possible to have filaments refitted at about half the price charged for a new valve.

One of the firms that undertakes this work is Revalco, Limited, with offices at 15, Grape-street, W.C. 2, and with works at Wimbledon. A few weeks ago we were afforded an opportunity of inspecting these works and of seeing how the new filaments are put into the valves.

Of course, if the bulb should be broken in transit, or accidentally in the repair works, a new one is blown, but in the ordinary way this practice is not resorted to. When the valves first reach the works they are handed to men known as "openers," who carefully nick the pip at the top of the valve and gently crack it all round so that the air may rush in at a reasonable speed. The next operation consists of fusing a short length of tube to the bulb, as shown in Fig. 1, where it will be seen that the tube is constricted at the point where it joins the bulb. Having fixed on the tube, the operator then plays a small blow-pipe flame on each side of the bulb, opposite the ends of the filament, until the glass becomes soft and pliable. Pressure is then applied to the interior of the valve, thus causing the glass at the hot and pliable spots to swell out into small and extremely thin globules, which are cracked and broken away.

The valves are then passed on to girls, who fit the new filaments, as shown in Fig. 2. The filaments

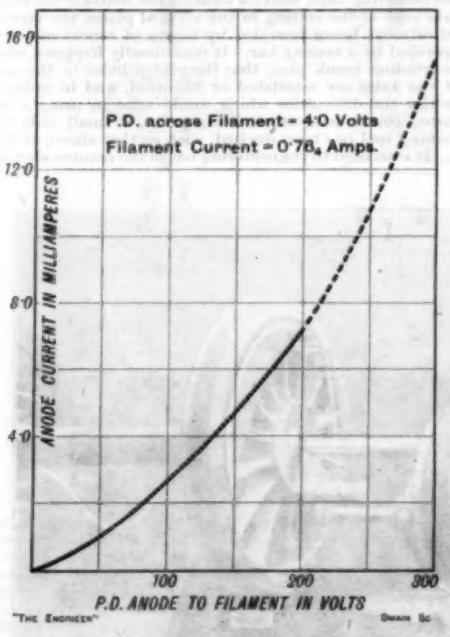


FIG. 5

are composed of fine tungsten wire, which is carefully crinkled before it is inserted into the valves, the object of crinkling being to give the filament a certain amount of flexibility which enables a fairly heavy tension to be applied to the clips that hold the wire. These clips are firmly pressed down on to the filament, which, on account of its springiness, is able to withstand mechanical strain, and it does not sag when it is heated. The filament is inserted into the bulb with a small pair of long-nosed pliers, the filament being passed completely through the grid, and after it has been pinched between the clips the surplus wire is cut off.

The valves then pass on to other operators, who apply a blow-pipe flame to the edges of the holes in the bulb, and by means of rods of special glass the holes are carefully closed again. This operation is carried out with very great care and in such a manner that the whole of the glass applied by the rods is ultimately removed and only the original glass remains, the object being to prevent porosity, which is apt to arise if foreign glass is infused into the original glass. When this closing up process has been completed, the valves are ready for exhaustion, which is done on a special pump which really consists of two pumps, and on account of the high degree of vacuum necessary, the connections between the valves and pump are made with glass tubes with fused joints. The initial stage of the exhausting pumps is first brought into use, and whilst the bulbs are raised to a temperature of between 300 deg. to 400 deg. Fah., by means of a small electrically heated oven, a fairly high degree of vacuum is produced within the bulbs. The second section of the pump, which works on the mercury vapour principle, is then switched on, and the very high degree of vacuum necessary within the bulbs of valves is then obtained. At the same time the filament is switched on to a low-pressure supply circuit, and the voltage is gradually raised to the full value. A high plate current is also applied so as to liberate any occluded gases in the plate, filament and grid, and during this process the plate heats up to a bright red. When the desired degree of exhaustion has been attained, a rotary blow-pipe flame is applied to the top of the valve, and the flame is rotated until the glass is sealed off. Residual gases liberated from the plate, filament, grid, or glass, are absorbed by a chemical preparation which, of course, is inserted into the bulb during the repair process.

After the valves have been sealed at the exhausting pumps shown in Fig. 3, they are ready for the ageing process, during which the filaments are supplied with current at a pressure of about 4½ volts, and 250 volts are applied to the plate. The ageing process lasts from half an hour to one hour, and before the valves leave the works they are tested on an actual receiving set, as high and low-frequency amplifiers and detectors.

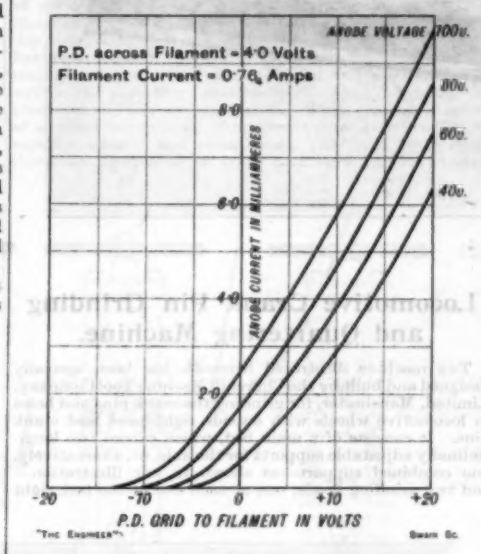


FIG. 6

A view of the testing department is shown in Fig. 4. Readings of the filament current and plate current are taken on all valves, and a special test is carried out to ensure the requisite degree of hardness. Characteristic curves are also taken on sample valves from various batches, so as to ensure that the whole of the work going through the factory is well up to the usual standard.

Some time ago a Marconi Osram valve which had been repaired at these works was sent to the National Physical Laboratory for a test. The report issued by the National Physical Laboratory states that the valve was connected up to the necessary direct-current supply circuits, and the potential difference between the filament terminals was maintained constant at 4 volts, the corresponding current passing through the filament being .764 ampères. Under these conditions the anode current passing through the valve was measured, whilst the potential difference between the anode and the negative filament terminal was increased regularly from 0 to 300 volts, and during this test the grid was connected to the negative filament terminal. The results of this test are given in the curve of Fig. 5. For anode potentials greater than 200 volts, the anode current was somewhat unsteady. With the filament supply conditions as before, and with a constant potential difference between the anode and negative filament terminal, the anode current was measured, while the potential between the negative filament terminal and grid was varied between — 20 and + 20 volts. This test was made with anode potentials of 40, 60, 80 and 100 volts, and the results are given in the curve, Fig. 6. We may add that we have had two French R valves repaired at these works, and they are giving quite good results.

The Road Fund Annual Report.

THE report on the Administration of the Road Fund for the twelve months, April 1st, 1922, to March 31st, 1923, has now been published and copies may be obtained through any bookseller, or directly from H.M. Stationery Office. From it we learn that the total receipts of the Road Fund during the period under review amounted to £12,802,754, of which about 11¾ millions came from the Motor Tax Account. The total shows an increase of about one million pounds on the corresponding figure for the previous year. The estimated number of motor vehicles for which licences were taken out was 979,000, the corresponding figure for 1922 being 873,665. The costs of collection and general administrative and miscellaneous expenses amounted to about £400,000. This figure includes the total costs of collection of the licence duties by local authorities, and also embodies practically the whole cost of the Roads Department of the Ministry. The costs of collection have been reduced from 3 per cent. of the revenue collected in the preceding year to 2.43 per cent.

During the year grants of over 14¼ million pounds—England and Wales, £12,727,424; Scotland, £1,548,753—were made from the Fund, and the present commitments, so far as can estimated, are over 16¼ million pounds. These commitments exceed the balance in hand by over £800,000, but, by arrangement with the Treasury, the future revenues of the Road Fund have been anticipated to enable commitments to be entered into in connection with works especially expedited with a view to the relief of unemployment. During the past three winters assistance from the Road Fund in respect of these works, amounting to over 14¼ million pounds, has been offered towards schemes of which the total cost exceeds 26 million pounds. Of this latter figure, nearly 4¼ million pounds relate to work in the metropolitan area, towards which over 3½ million pounds has been indicated in grants. The figures quoted above relate to the Road Fund unemployment programmes for 1920–1923, and *do not* include the further assistance from the Fund for the year 1923–1924, which has recently been announced, towards schemes to the value of about £14,000,000.

An account, illustrated by diagrams, is given of some of the more important road schemes now under discussion. They include the Liverpool-Manchester road, the Glasgow-Edinburgh road, the Newcastle-on-Tyne-Tynemouth road, the Birmingham-Wolverhampton road, and the Glamorgan-Inter-Valley commmunication road In addition, considerable information is given regarding many other important works of road construction and improvement which have been put in hand during 1922–1923, both in London and in Scotland and the provinces.

Some of the most interesting information included in the report is contained in the paragraphs (17–26) dealing with the Census of Traffic on Class I. roads in Great Britain—excluding London and certain County Boroughs—which was carried out during the month of August, 1922. Prior to that time, no attempt had ever been made to obtain statistical information as to the nature, density and weight of traffic on the more important roads of the country as a whole. As illustrating facts which have been obtained, it may be mentioned that the census point with the highest daily average of traffic was one just west of Ilford Station, on the London-Colchester road, where a total of 14,536 tons per day was recorded. The lowest recorded was at a point in Ross and Cromarty, with but 14 tons per day. A remarkable comparison may be made between these figures and the following London figures taken from the records of the police authorities :—

	Tons per day.
Hyde Park Corner	115,090
Piccadilly-circus	94,728
Mansion House	86,046

We understand that a separate report in much greater detail will shortly be issued.

Fairfield-Sulzer Diesel Engines.

CONSIDERABLE interest centres around the four sets of Fairfield-Sulzer Diesel machinery which the Fairfield Engineering and Shipbuilding Company, Limited, is building at Govan for the Aorangi, the new passenger liner for the Union Steamship Company, Limited, of New Zealand. It will be recalled that this ship was ordered nearly a year ago, and that she is a 20,000-ton vessel with the following dimensions:—Overall length, 600ft.; breadth, 72ft.; moulded depth, 37ft. 6in.; with a sea speed of about 17 knots. This quadruple-screw liner will be propelled by four two-cycle engines of the Fairfield-Sulzer type. Each engine has six cylinders, with a bore of 27½in. and a stroke of 39in., and is designed to develop 3500 brake horse-power when running at 130 to 135 revolutions per minute. The total horse-power developed under sea service conditions will probably be 12,500, but on test it is expected that about 14,000 brake horse-power will be obtained.

We were recently accorded the privilege of seeing the machinery under construction at the Govan yards, and of inspecting, in particular, the starboard and port wing engines, which are rapidly approaching completion, and will, it is expected, undergo preliminary tests before the end of the present month. While embodying the many well-known features of the Sulzer design, these engines are of outstanding merit, because they are fully representative of the best Clyde marine practice. Particular attention has been concentrated on the design of the bed-plate and the stiffening of the tank top, to which it is secured, so that all possibility of vibration is eliminated. The outer walls of the bed-plate are of deep and well-proportioned double section, with transverse members between the main bearings. This design gives a continuous line of bolting on the outer edge of the bed-plate, and inner bolts which are reached through inspection doors in the bottom of the oil space formed between the outer members. The crank shaft is partly built up, and the main and crank pin bearings and main crosshead pins have been increased in dimensions to reduce the bearing pressures. The crank casings are of robust design, and are furnished with light steel doors, giving access to the crank chambers. As the stroke of the engines is slightly shorter than usual, the cylinder casings are compact in appearance. Mention may perhaps be made of the fastening of the piston crown to the piston-rod, which is made through long bolts and distance collars, imparting flexibility. The question of piston cooling arrangements for these particular engines has been the subject of careful investigation by the Fairfield Company, and a special test unit with a piston crown furnished with glass inspection doors was made for the purpose of making extensive experiments. A modified cooling system by which the space in the piston crown is always kept drowned with cooling water, has been evolved and will be fitted throughout the installation. Another improvement is the light automatic disc valves which

DOUBLE-HEADED CRANK-PIN GRINDING MACHINE

THE CHURCHILL MACHINE TOOL CO., LTD., BROADHEATH, MANCHESTER, ENGINEERS

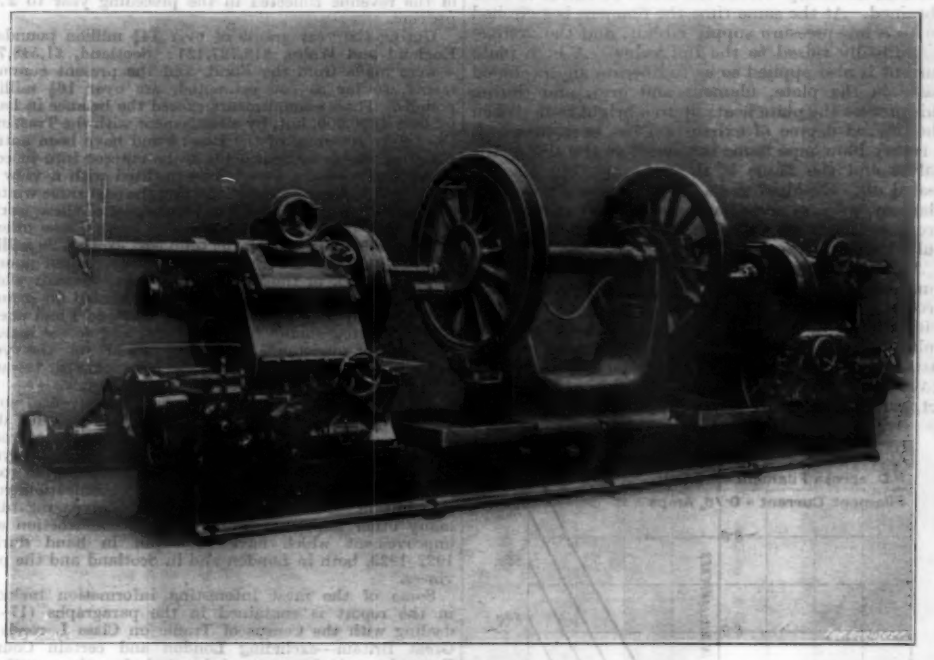


FIG. 1

replace the rotary scavenge air control valves in the latest Sulzer design. These disc valves are fitted into the standard scavenge air casings.

As in other Sulzer-engined ships, the starting and manœuvring controls will be situated at the forward ends of each engine on the top platform. This platform is particularly roomy and well planned, and we were impressed by the general neatness of the pipework and the lay-out of platforms and access ladders. We have no hesitation in saying that these engines are the finest of their type which we have yet seen, and Mr. Robert Traill and his staff are to be congratulated on the way in which the design and arrangement of the installation has been carried out. Very complete testing equipment has been placed in readiness in the main erecting shops. It is hoped that it will shortly be possible for the Fairfield Company to invite marine engineers and shipowners to see the first two engines running under trial conditions, and we venture to think that the occasion will be one of unusual interest for all who regard with satisfaction the steady and sure advance of the British-built marine oil engine.

THE INSTITUTE OF CHEMISTRY.

THE forty-sixth anniversary dinner of the Institute of Chemistry was held at the Hotel Victoria on Monday evening. This Institute, we may remind our readers, only celebrates its anniversary by a dinner once in every three years. It was founded in 1877 and incorporated by Royal Charter in 1885. The President for this year is Mr. A. Chaston Chapman, and he occupied the chair on Monday night, with Lord Haldane on his left and Lord Milner on his right. Owing to a slight mishap Lord Milner was obliged to leave the hall during the dinner. It was announced that a small bone had lodged in his throat and that a surgeon had to be called in to remove it. The toast of the evening—that of the "Institute"—was proposed by Lord Haldane. He said that the Institute was a body which sought to combine science and organisation, and he knew of nothing that was so greatly needed as such a combination at the present time. He threw his mind back to the science of the forties and the fifties. It was, he thought, an abstract science with very little relation to industry, and manufacturers were able to get on very well without it, but as soon as the new discoveries began to be applied to industry a change took place. The present century had been a most fruitful one in the production of scientists, and while here we did not turn out, possibly, as many scientists as were turned out on the Continent, he was sure that those we did produce were more frequently of a higher order. He was one of those who believed that science was always the work of individual genius and could never be produced by the State. In replying to the toast, the President said that the Institution had on its register the names of no fewer than 1615 fellows, 2714 associates, and 862 registered students, making a grand total of well over 5000. A man bearing the hall mark of the Institute was one whom the public might trust implicitly in respect to training, knowledge, character and professional conduct. Professor Arthur Smithells proposed the "Houses of Parliament," and Lord Haldane, in the absence of Lord Milner, briefly acknowledged it. There were many other speeches during the evening, of which we may mention Lord Burnham's toast of "Science and Industry." He held that there were now no more convinced believers in technical education, based on general knowledge, than the enlightened captains of industry of to-day.

The company was a very large one, and in it were included many of the most eminent scientists of the day.

A NEW station, called Hillingdon, and situated between Ickenham and Uxbridge, was opened by the Metropolitan Company on Monday last.

Locomotive Crank Pin Grinding and Quartering Machine.

THE machine illustrated herewith has been specially designed and built by the Churchill Machine Tool Company, Limited, Manchester, for grinding the crank pins and holes in locomotive wheels with outside right-hand lead crank pins. It consists of a main bed, which carries two longitudinally adjustable supports for the axle, or, alternatively, one combined support—as shown in our illustration—and two grinding heads, one at each end of the bed, right and left hand, but operated from the same side of the machine. Each grinding head is driven by an independent motor, or can be arranged for an independent overhead countershaft drive.

The grinding heads are carried on slides at 90 deg. to each other, and are adjustable on the angular slides by means of fixed dead stops arranged in 1in. steps, so that effective throws of from 11in. to 15in. may be dealt with. The axle is supported on its journal in vee steadies, which are vertically adjustable. The axle is located accurately for centre height by means of a centering bar carried on each grinding head and at the bi-section of the 90 deg. angle formed by the slides carrying the two grinding heads.

The grinding heads are mounted on tables bolted to the bed, and have an automatic traverse on the slides of 24in. This traverse covers the grinding of pins up to 15in., and the grinding of parallel crank pin holes in the driving wheel. The main spindles in the grinding heads are 6in. diameter in the main bearing. They are provided with ball thrusts for drilling and boring. The grinding snouts are detachable, so that various sizes can be used.

In addition to the traverse speeds for grinding the pin, a range of boring feeds, necessarily much slower than the grinding speeds, is provided for. These boring feeds are provided so that the machine can be fitted with tools for the purpose of drilling and boring holes in a new driving wheel, or, alternatively, they can be used in conjunction with turning tools for the purpose of turning a pin, assuming there is more metal to be removed that it would be advisable to take off by grinding only.

Each of the slides carrying the grinding or boring snouts is arranged so that it can be brought to a position coinciding exactly with the centre of the main spindle, and for this purpose a dead stop is provided. A special quick cross adjustment of 5½in. is also provided. The traverse

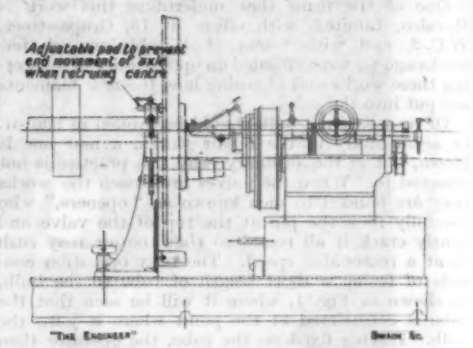


FIG. 3—TURNING TOOL FOR CENTRE HOLES

feeds to the grinding heads and the rotary motion to the main spindle are obtained from a gear-box, which provides for three boring feeds, three grinding head traverse speeds and three rotary speeds to the main spindle.

Of the illustrations, Fig. 1 is a front view of the machine showing the left-hand head in detail; Fig. 2 is a larger view of one head showing the centering bar in position. The vee journal rests permit of accurate alignment of the crank pins and axles in the horizontal plane while the centering bars, used for locating the centre of the axles, take care of the setting in the vertical plane, the vertical adjustment being provided by means of screws and nuts operated by a tommy bar. It occasionally happens, when re-grinding crank pins, that the centre holes in the ends of the axles are mutilated or distorted, and in order to rectify the difficulties which would arise in using a distorted centre hole as a setting point, a small slide rest turning tool has been devised, such as that shown in Fig. 3. It is secured to the centering bar in the manner shown.

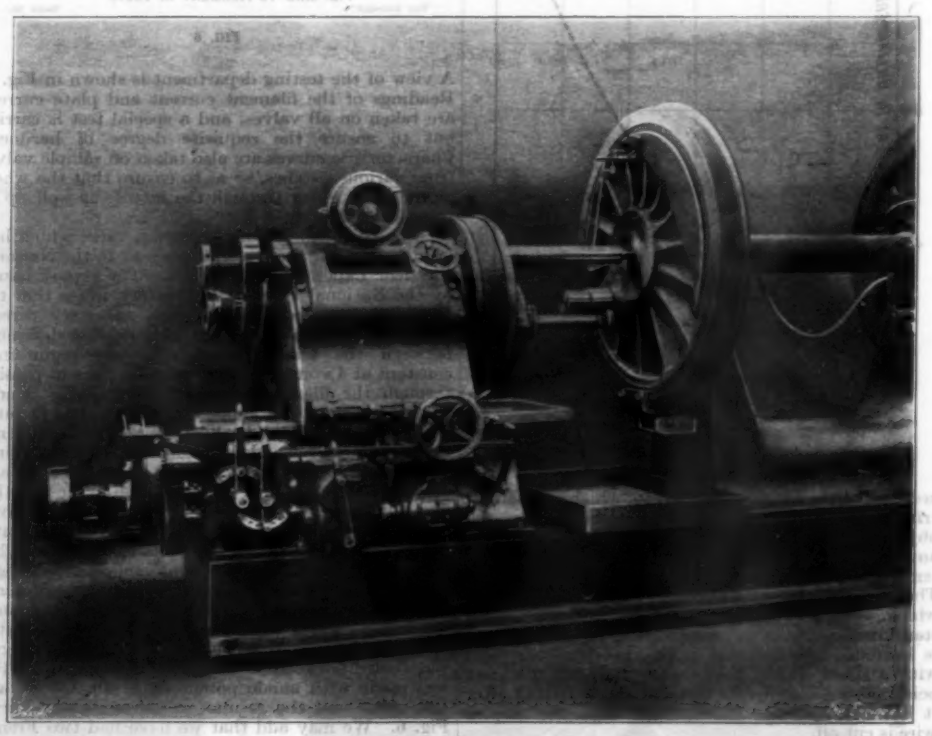


FIG. 2—VIEW OF ONE HEAD WITH CENTERING BAR IN USE

The leading dimensions of the machine are as follows:—

Disposition of grinding spindles	90 deg.
Maximum diameter of pins ground	7in.
Maximum length of pins ground	15in.
Radius of pins from axle journal centre	11in. to 15in.
Maximum excentric stroke of grinding spindle or turning tool	1¼in.
Minimum excentric stroke of grinding spindle or turning tool	Zero
Number of drilling and boring feeds	Three
Amount of feed in inches per minute	.05in., .087in., .184in.
Number of grinding traverse speeds	Three
Amount of feed in inches per minute	.803in., 1.37in., 2.3in.
Spindle speeds	25, 45 and 60 r.p.m.
Longitudinal travel of grinding head	24in.
Extra adjustment of bed or base plate	12in.
Overall floor space, length exclusive of motors	22ft.
Overall floor space, width exclusive of motors	6ft.

A Quick-closing Sluice Valve.

SOME little time ago we made a brief reference, in our Patents columns, to the quick-closing sluice valve made by Alley and MacLellan, Limited, of Worcester, under Gardner's patents, and are now able to give more detailed drawings of the mechanism.

This valve has been designed with the object of providing a check against the extension of accidental fires in oil fuel installations, by enabling the flow of oil in the piping system to be rapidly shut off from a distance. It is, by the way, one of the requirements of the Board of Trade that a valve which can be closed from a distance shall be fitted in the flow pipes from all oil fuel storage tanks or settling tanks.

In the case of marine installations, it is not an easy matter to arrange for a screw-down valve to be operated from the deck, on account of the gearing and shafting that must be used to get round obstacles on the way, while there is always a risk of the operating gear jamming on account of the ship "working" in a seaway. Such a valve also has the disadvantage that it takes an appreciable time to screw it down. The Sentinel valve under review, however, can be closed instantly by merely pulling on a wire rope, and a rope is obviously more adaptable to leading away to a distance than is a stiff shaft.

The mechanism for closing the valve is best shown in Fig. 1, while its operation is illustrated by Figs. 2 and 3. The screwed spindle A, fitted with the hand wheel B, is rotatable, but not movable axially in the fixed bridge C carried by the fixed pillars D. The screw engages with the crosshead E, which is prevented from rotating by engagement with the pillars. The crosshead carries a horizontal shaft F, on which are fixed the cranks G. The cranks are jointed to the connecting links H, the other ends of which are jointed to the valve spindle J by means of the crosshead M. The valve spindle is directly attached to the gate or sluice, which is always urged towards the closed position by the springs shown. The trip mechanism described is maintained in the rigid or non-operative position by the abutment of the stop lever K against the crosshead E.

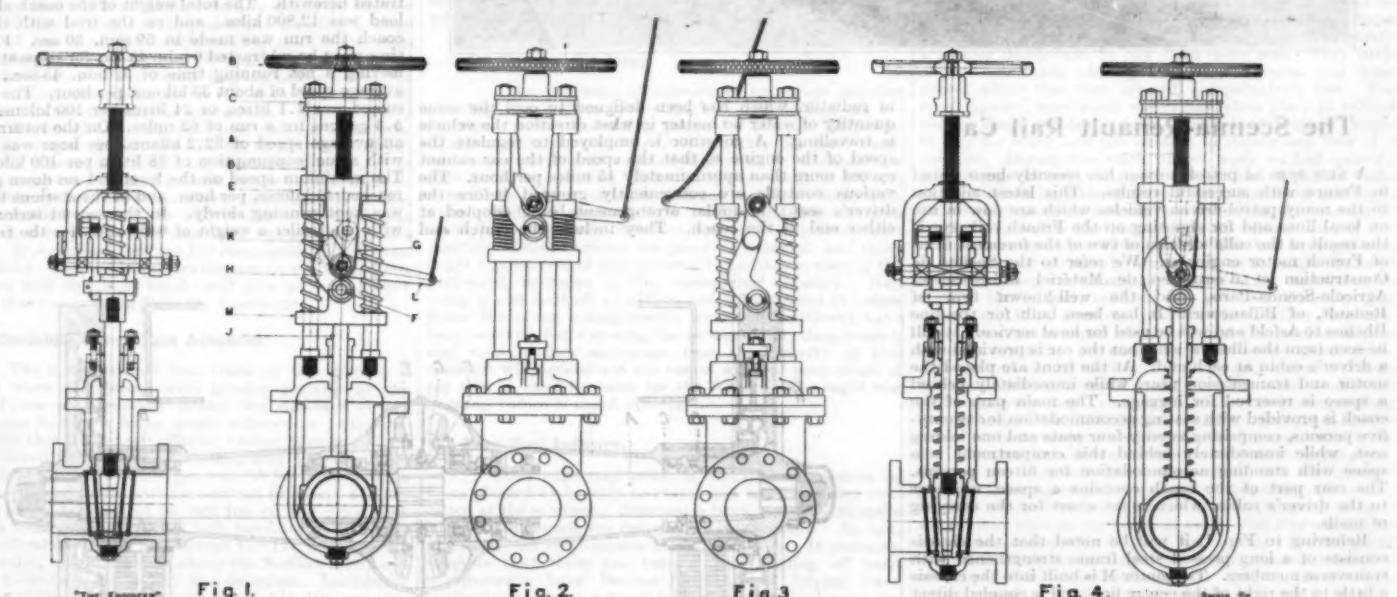


Fig. 1. Fig. 2. Fig. 3 Fig. 4.

QUICK-CLOSING SLUICE VALVES

When the valve, along with the trip mechanism as a whole, has been lifted by means of the hand wheel and screw, the springs are compressed, but the valve is held open as the links G and H are in the doubled-up position, and are kept so by the stop K. It will be noticed that the top pin joint of the links is just beyond the dead centre. If, now, the lever L is pulled up the cranks G will be rotated past the dead centre, to the left, and the springs will immediately open out the links—as shown in Fig. 3—and close the valve. The links have, of course, to be re-set before the valve can be reopened.

The operating lever can be made sufficiently long to give a very easy trigger action, and can, by means of a chain or wire, be operated from a distance. It can be made sufficiently heavy and arranged at such an angle as to ensure that the trip gear will be automatically re-set when the top spindle is screwed down in readiness for opening the valve. By the temporary application of a lengthening piece, such as a tube, the operating lever can be used to reopen the valve and re-set the trip after rapid closing. The employment of an outside screw enables the weight of the rapidly moving parts to be reduced to a minimum.

Fig. 4 shows an alternative design of valve, with the spring housed in the valve body or casing. The internal spring is not recommended where acids are present in the fluid passing through the valves.

Use of Dehydrating Apparatus on Fruit Farms.

A COMMITTEE of the American Society of Agricultural Engineers has been investigating the possibility of more economic manufacture of farm products, particularly with a view to showing the farmer the profits of such practice as compared with the usual practice of selling farm products as raw material. In this way products may be utilised which are now wasted or lost owing to small size, poor quality, discoloration, over-ripeness, lack of railway wagons, or glutted markets. An unstable product as raw material may often be converted into a stable commodity which can be stored to await favourable market conditions. In addition, many such manufacturing products will yield a by-product of fertilising value; and, finally, the introduction of such processes should render farming more attractive to the younger generation and thus check the general flow of population to the cities. The findings of this Committee should be of interest to our readers in Australia, New Zealand and South Africa, no less than to British manufacturers of the necessary equipment.

As to manufacturing materials for his own use in farming, the Committee doubts whether the farmer can afford to compete with regular manufacturing methods. If he has spare time it should be devoted rather to farming larger areas or engaging in some profitable occupation. Many manufacturing processes can be carried on more economically in a central factory, so that the Society has an opportunity to help in problems connected with the equipment and operation of the farm or small co-operative factory.

Dehydrators used on farms in California occupy a large part of the report, including a paper by Professor Christie, of the University of California, and Mr. Ridley, a mechanical engineer. Drying is the principal method of preserving California fruits, which are of world-wide distribution. In 1922 the production amounted to 395,700 dry tons, with a farm value of £9,315,000. Sun drying has been used for years, with a few artificial dryers, mainly for use in wet seasons or in bad weather. But within the past five years there has been a marked increase of the use of dehydrators. They are independent of weather conditions; they give a product of uniformly superior quality and cleanliness; they cost little more than the equipment in trays and land for sun drying on the same scale; and they are economical by the large saving in manual labour.

With an operating period rarely exceeding thirty days, low first cost and high capacity are more important than high operating efficiency. Engineers experienced in the fruit-drying problems have produced highly efficient and economical apparatus which can be entrusted to the operation of unskilled labour.

Heat is required primarily to evaporate the water content and to replenish heat lost with the escaping air, but it must also heat the trucks, trays and building, and replace heat lost by radiation. Air currents are required to carry the heat to the fruit and to carry off the moisture evaporated. Water in fruits contains sugar and other matter in solution, and is held in a fibrous structure. If the air is too hot and dry, the passages tend to be closed by shrinkage; hence, the humidity of the air must be so controlled that the rate of surface evaporation will not exceed the rate of moisture diffusion from the interior of the fruit structure. The so-called hydrators of the old kiln-dryer type, operating by natural draught, are defective in view of their lack of this humidity control. Modern natural draught hydrators are more efficient, and provide some control of humidity by dampers, or baffles, to direct the air circulation; but in all of them there is the objection of low velocity of air currents. Dehydrators of the vacuum type have too high a cost and require too much auxiliary equipment to be economically successful. Other types of limited use employ rotating drums, tilting trays and endless conveyors.

The air-blast dehydrator, in which the air current is provided by a fan, or fans, is the type most generally used, and is of two classes—the compartment class and the tunnel class. With the compartment dehydrator, the fruit is placed in a closed chamber and the circulation starts at low temperature and high humidity, changing gradually to finish at high temperature and low humidity. With the tunnel dehydrator, a long drying chamber is provided, but the air condition remains unchanged, the material being moved gradually from the entering to the discharging end, fresh materials being supplied continually to keep the tunnel full. The dehydrator will be equipped with trays, steel trucks—on lines of rails of 24in. gauge—transfer trucks, heating system, fan, return air flue and haulage system.

Trays used in hydrators are usually 3ft. by 3ft. or 3ft. by 4ft., with high sides and thin ends to give large spreading surface and least obstruction to flow of air. The bottom is of slats 1in. wide and just far enough apart to allow access of air to the underside of the fruit. Field trays are usually 3ft. by 8ft., with a 2in. rim all round and a solid bottom.

Heating systems may employ electric heaters, steam radiators, or gas, oil, wood, or coal furnaces. In any case, the system must be of ample capacity and be fitted for rapid control of temperature. The fans used have a large number of blades of short radial length, rather than a smaller number of long blades. The dehydrator building is usually of monolithic concrete or hollow tube or concrete blocks, with concrete slab roof.

INTERLOCKING RUBBER ROAD SURFACING BLOCKS.

ONE of the difficulties which have, up to now, faced constructors of rubber roads has been that of finding a suitable method of anchoring the blocks. It is claimed that, in a system of road covering invented by Mr. C. W. Read, this difficulty has been overcome.

Briefly, the system consists in the use of rubber blocks, or strips, vulcanised to stand hard wear, moulded in channel or U-shape, and in such lengths as may be required, the rubber being ¾in. thick on the tread, and ¼in. thick at the sides. The width to which the blocks can be made is, we understand, anything from 2in. to 2ft., and in lengths up to 100ft.

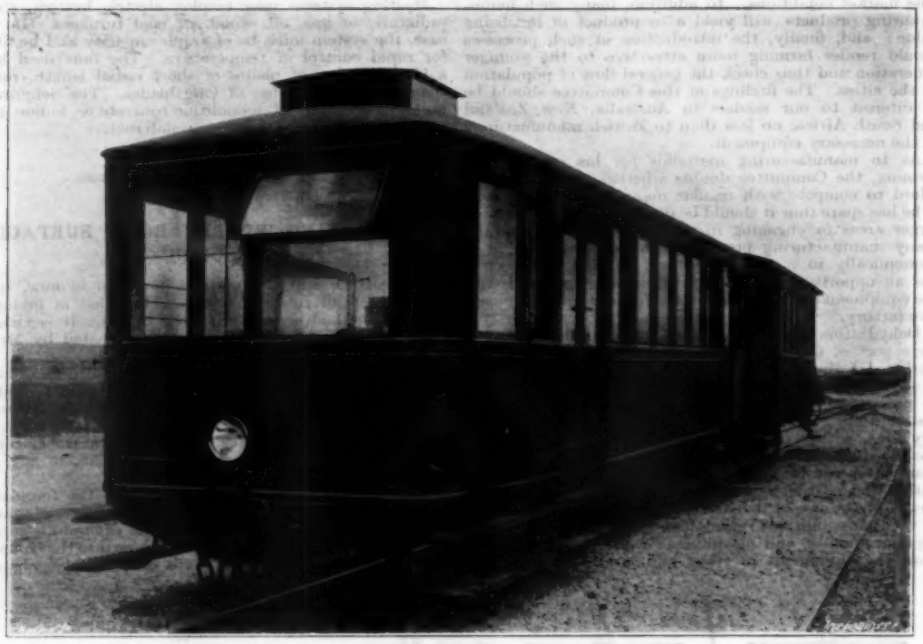
The method of laying is as follows:—The foundation of the road, which can be of any suitable material, having been prepared and levelled, a layer of concrete is spread, and, at intervals, slots are made 2in. deep into the concrete. These slots receive the side walls of the rubber channel, and form the anchorage for the rubber. A thin coating of bitumen is brushed on the concrete before the blocks are laid, but it is, so we gather, principally used as an undercoating, and is not necessary as a binding medium. It is claimed that the side walls of the rubber channel have such a grip on each other that it will be impossible for the rubber to move in any direction.

The Read blocks, or strips, are being made by F. and E. Stanton, Limited, of Conington-road, Lewisham, S.E. 13, who point out that solid rubber blocks, laid in brick formation, present difficulties as regards anchorage, while the depth of the blocks reduces the strength of the necessary foundation. With Read's system, the thickness of the rubber surface is only ¾in., which means, it is asserted, that the advantages and strength of a solid concrete road are obtained without any of the disadvantages usually experienced. It is stated, too, that the system is specially applicable to interior work, and as a floor covering; and that it is easily laid and as easily removed when necessary. It is anticipated that the fact that it can be supplied in a number of colourings should open up for it a wide field of utility.

As regards cost, it is claimed (*a*) that Read's system will work out at less than half the cost of any other rubber road covering; (*b*) will cost very little more than other forms of road covering already in use; while (*c*) the cost of upkeep and maintenance will be less than any form of up-to-date road covering.

IN the earlier years of the present century the names of Mackenzie and Mann—later Sir William Mackenzie and Sir Donald Mann—were household words all over Canada as builders of railways. To them was the Canadian Northern in particular due, and by that line and allied railways there was built another transcontinental system. The consequent competition severely injured the Grand Trunk and both systems were badly hit by the war. As a result all the railways of the Dominion, except the Canadian Pacific, passed into the hands of the State. The activities of Sir William Mackenzie as a railway builder thus came to an end. These thoughts have been prompted by the news that, after a month's illness, from which he rallied for a time, Sir William died on the 5th instant.

THE SCEMIA-RENAULT RAIL CAR



The Scemia-Renault Rail Car.

A new type of petrol rail car has recently been tested in France with successful results. This latest addition to the many petrol-driven vehicles which are now in use on local lines and for shunting on the French railways is the result of the collaboration of two of the foremost firms of French motor engineers. We refer to the Société de Construction et d'entretien de Matériel Industriel et Agricole-Scemia-Paris, and the well-known firm of Renault, of Billancourt. It has been built for the line Rheims to Asfeld and will be used for local service. It will be seen from the illustrations that the car is provided with a driver's cabin at each end. At the front are placed the motor and transmission gear, while immediately behind a space is reserved for luggage. The main part of the coach is provided with seating accommodation for twenty-five persons, comprising twenty-four seats and one folding seat, while immediately behind this compartment is a space with standing accommodation for fifteen persons. The rear part of the coach contains a space, adjacent to the driver's cabin, which is set apart for the carrying of mails.

Referring to Fig. 1, it will be noted that the chassis consists of a long pressed steel frame strengthened with transverse members. The motor M is built into the chassis a little to the right of the centre line, and is coupled direct to the clutch and gear-box N, from which a transmission shaft O is taken right through to the drive P on the rear axle. In the vehicle we are describing only the back axle is driven, but other types of car are under construction with two driven axles. With such an arrangement a direct drive on the fourth speed is obtained with a correspondingly high efficiency of transmission. The engine runs at a normal speed of 1600 revolutions per minute and the gear-box provides a triple speed change with four speeds and one reverse in each direction as follows :—

Gear.	Speed, kilom. per hour.
4th	40
3rd	26.3
2nd	15.3
1st	10.46
Reverse	10.46

The motor has four cylinders, each 100 mm. diameter by 160 mm. stroke, and its design follows the usual Renault practice. It may be mentioned that thermo-syphonic cooling is employed in connection with a type of radiator, which has been designed to cool the same quantity of water no matter in what direction the vehicle is travelling. A governor is employed to regulate the speed of the engine so that the speed of the car cannot exceed more than approximately 45 miles per hour. The various controls are conveniently grouped before the driver's seat ; a similar arrangement being adopted at either end of the coach. They include the clutch and electric starter pedals, the accelerator and foot brake pedals, and the speed change and hand brake levers. There are also levers controlling gas and air, the sanding devices and the whistle. Opposite the driver is placed a tachometer showing the speed at which the engine is running, thus enabling him to carry out easily the necessary speed changes.

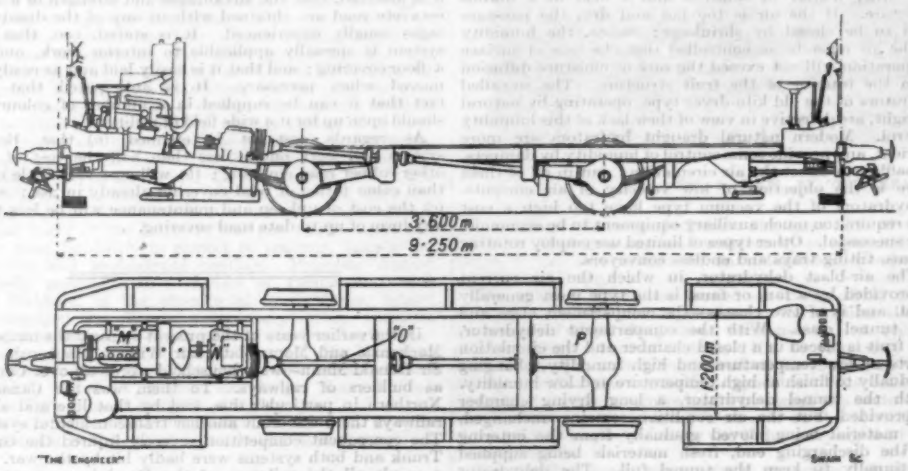


FIG. 1—CHASSIS OF SCEMIA-RENAULT RAIL CAR

An interesting part of the mechanical arrangement is the back axle drive shown in section in Fig. 2. The cardan shaft is attached to a pinion engaging with one of two crown wheels E, which run loose on the main axle and are supported on roller and ball bearings housed in the main casing. A sliding pinion F is splined on to the axle, and by moving it to the right or left by means of a forked member which engages with the centre ring G, reversal of the direction of motion of the axle is obtained. Each axle-box is furnished with both roller and ball bearings B and C and on the inner sides of the wheels are brake rings with internal expanding shoes H. These brakes are operated by hand. The foot brake, on the other hand, controls shoes lined with "Ferodo," which grip a brake drum placed on the driving shaft immediately behind the gear-box. The driving wheels are made so as to be detachable and are mounted on coned sleeves so designed that each wheel can be quickly dismantled for examination of the bearings and for the replacement of tires. Reference may be made to the springing of the chassis and the coach. At each end of the axles are laminated springs K attached to the axle casing on the inner side of the wheels. The body of the car rests on vertical spiral springs placed at the extremities of the laminated springs, these spiral springs being so proportioned that they take up light shocks which are insufficient to overcome the resistance of the laminated springs ; by this means a double suspension is obtained. Lateral shocks are absorbed by a new form of oscillating spring suspension. The shackles by which the chassis is attached to the vertical suspension springs are formed of laminated spring members, which enable them to move in a horizontal direction between stops placed at a distance of 20 mm. each side of the vertical position. The reports we have received of the trial results would seem to show that the car is particularly smooth in service and that the work of the conductor and driver is performed with ease both during running and shunting.

Some particulars may be given of the tests made at the beginning of last month on the line Rheims to Asfeld, which has a length of 29½ kiloms., with gradients up to 1 in 30 and 40. Trials were made with the loaded coach alone and also with the coach and one trailer, as illustrated herewith. The total weight of the coach alone with load was 12,800 kilos., and on the trial with the single coach the run was made in 59 min. 30 sec. From this time must be subtracted 6 min. 45 sec. for stops at stations, leaving a net running time of 52 min. 45 sec., with an average speed of about 33 kiloms. per hour. The fuel consumed was 7.1 litres, or 24 litres per 100 kiloms.—about 5.3 gallons for a run of 62 miles. On the return journey an average speed of 32.2 kiloms. per hour was attained with a fuel consumption of 28 litres per 100 kiloms. run. The maximum speed on the level and on down gradients reached 45 kiloms. per hour, and at the stations the motor was kept running slowly. In the second series of tests with one trailer a weight of 6400 kilos. for the trailer was added to the 12,800 kilos. of the loaded coach. The complete outward and return journey was made in a time of 2 h. 20 min. 15 sec., or a net time of 1 h. 59 min. 45 sec., when allowance was made for the seventeen stops *en route*. An average speed of 25 kiloms. per hour was maintained and the petrol consumed was 17.3 litres, or 29.6 litres per 100 kiloms.

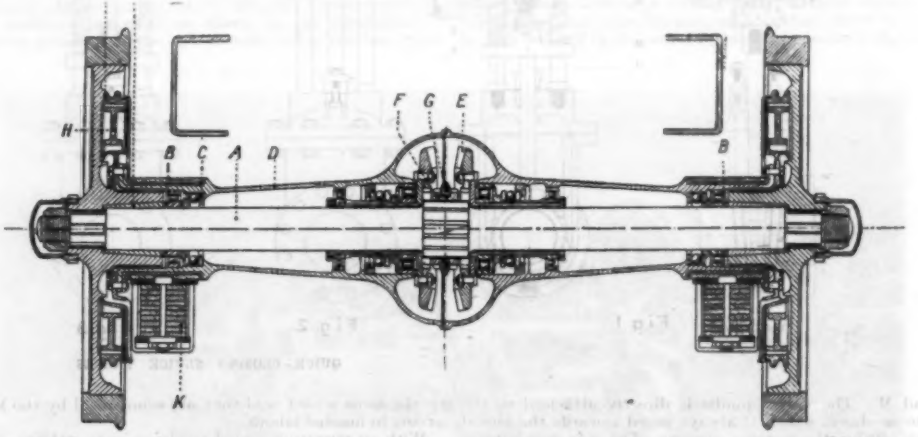


FIG. 2—BACK AXLE

The principal dimensions of the vehicle are :—

Overall length of coach, excluding buffers	9.40 m.
Wheel base	3.6 m.
Overall width of coach	2.40 m.
Overall height from top of rails	3.35 m.
Diameter of wheels	0.845 m.
Weight complete, but unloaded	9.2 metric tons
Horse-power of motor	45

The vehicle we have described will be used on the line d'Epernay-Ay-Mareuil-sur-Ay. It forms part of an order for four such rail cars which are ordered for the Rheims local line service. Actually a series of ten coaches of this type are at present under construction in the Renault works. It is expected that La Société des Transports en commun de la Région parisienne will put into service rail cars built for normal gauge, which will be finished before the end of the year. Also La Compagnie Générale des Voies ferrées d'interêt local has placed an order with the Scemia Company for a 1 m. gauge rail car for its Pas-de-Calais services.

We would express our indebtedness to our French contemporary, *Le Génie Civil*, for the drawings Figs. 1 and 2 illustrating this article.

The Melbourne *Herald* states that the Melbourne and Metropolitan Tramways Board expects to spend nearly £2,000,000 in extending tramway facilities by the end of 1925. Of this sum £800,000 will be spent on new lines. The Board has acquired 16 acres of land at Preston, on which to erect what will probably be the largest workshops in Victoria.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Business Brisk.

BUSINESS on the Birmingham Iron and Steel Exchange to-day (Thursday) was brisk, and a considerable tonnage of orders was given out. Sellers did not encourage the placing of forward contracts, preferring to wait for higher prices. Some manufacturers, indeed, quoted well above the market level in order to discourage business. Now that the election is out of the way, it is anticipated that the recent improvement in business will be extended, bringing enhanced values in the New Year. Constructional engineers in the Midlands are finding more inquiry, but the tonnages involved are said to be relatively small. Work, however, appears to be assured for some months. The rolling stock firms are also well employed, and are calling for fair quantities of material, while some improvement in the South Staffordshire nut and bolt industry is having a brightening effect upon the finished ironworks. Pig iron, particularly forge qualities, has a ready sale.

Continental Competition.

Continental competition in both iron and steel has of late become much more pronounced. Seeing values rising here, the foreigner—who in many cases was forced to abandon the market by the action of native manufacturers, who in order to regain the market lowered their prices to below the profit-making level—is again making an attempt to get a hold on business. Those steel makers who have raised the standard of small steel bars to £11 have to contend with Belgian competition at something like £9 per ton. Billet makers who now quote £8 15s. for mild steel billets find continental firms securing a large volume of the available business at a price more than 25s. per ton below their own. It is possible also to buy foreign finished steel well below English prices, joists, for example, being obtainable at £8 10s. delivered, or about £1 5s. below native makers' quotations. Belgian No. 3 iron can be bought for nut and bolt making at £8 15s. delivered, compared with £10 17s. 6d. to £11 for Staffordshire iron. There is no doubt but that the Belgians, after taking a somewhat languid interest in the British market, have suddenly become keen sellers. The statement that they were filled up until the end of January, which was commonly accepted a short time ago, was apparently not correct. It is realised that the full resumption of activities in the Ruhr—and the latest developments would lead one to expect that this is at hand—will give an even keener edge to this competition from the Continent.

Staffordshire Crown Bars Advanced.

The manufactured iron trade in this district is showing more animation, with greater activity at the mills. Prices are decidedly firmer, the standard of £12 for medium bars now being firmly adhered to. Staffordshire mills that have been offering Crown bars at £12 5s. have followed the lead of Lancashire and Yorkshire and put up their price to £12 10s. per ton. A few mills making hardly such good grade bars are content to accept £12 5s., but this is an advance of 5s. per ton on the price they named a week ago. Nut and bolt bars are also dearer. Some Staffordshire firms may accept £10 17s. 6d. to secure a good order, but £11 is now about the market level, and forward business is taken only at a premium. Lancashire houses competing in this district quote £11 10s. per ton. Were local makers inclined, they could book substantial orders for the New Year, but they declare that costs are rising all round. The Darlaston nut and bolt industry is, I am happy to be able to record, reviving under the stimulus of the return of peace to the shipyards and prospective demand in connection with Government schemes. The outlook is decidedly better than it was a few months ago. Belgian No. 3 iron is being offered to nut and bolt makers at £8 15s. delivered. With an advantage of £2 5s. per ton over Staffordshire prices, the Belgians are securing a goodly number of orders. Makers of marked bars in this district continue well employed, and have no difficulty in getting £14 10s. per ton for their iron. Wrought iron gas tube strip commands £12 10s. to £12 15s. per ton.

Galvanised Sheet Mills Busy.

The galvanised sheet mills continue in a strong position, with bookings covering the first two months of next year. A lull, usual at the end of the year, is reported in the export demand. Makers, however, are comfortably booked, and a revival of export buying is expected with the coming of the New Year. The basis of £19 for 24 gauge corrugated sheets is maintained in spite of the higher cost of spelter.

Raw Iron Values Rising.

There is a greater activity in the Midland pig iron market than has been seen for many months past, and prices of both forge and foundry grades continue to rise steadily. Again this week the appreciation is more pronounced in forge qualities than foundry. The output of forge pig has shrunk to such small dimensions that it did not require a great expansion of demand to bring about a market stringency. A number of contracts have been placed by Staffordshire ironmasters, who are anxious to ensure their pig iron supplies for three months forward. Makers are more ready to sell now that coke prices appear to be stable until the end of March. North Staffordshire forge iron has advanced 2s. per ton to £4 10s. Northamptonshire forge has risen from £4 6s. to £4 7s. 6d., while Derbyshire now commands £4 9s. to £4 10s. The demand for foundry numbers does not seem to have kept pace with that for forge sorts, nor is there the same growing activity in the Midlands as is reported from the Cleveland district. Values are, however, firmer, and in some cases 1s. per ton better than last week. Though Derbyshire foundry iron has not gone beyond £4 15s., the minimum has risen from £4 12s. 6d. to £4 13s. 6d. The £4 12s. 6d. quotation for Northamptonshire iron has disappeared, £4 13s. 6d. having become the market level. The casters of heavy rolls, &c., are busy supplying plant to the steel and tinplate works, and this has improved the demand for cold blast iron. Supplies of this material are now rather difficult to obtain. Pig iron production tends to increase, but in this area makers with idle plant consider the present selling rates unprofitable, and will keep their furnaces unemployed for the present.

Steel Values Firm.

The steel market continues bright. Bookings have been continuous during the past week, very large orders having been placed for billets and semi-finished material generally. A good proportion of the business has, however, gone to Belgium at a figure round about £7 12s. 6d. Native steel billets are at a level of £8 15s., but many firms ask £9. Local works are fairly favourably situated for orders, but there are complaints of unprofitable production. In view of foreign competition, steelmasters are handling prices cautiously. In a few exceptional cases this week transactions are reported to have taken place in mild steel billets at below the £8 15s. level. Sheet bars command from £8 5s. to £8 10s. Small steel bars are £11 nominal basis, £10 15s. being accepted for big business. While no formal change has been made in the £10 minimum for ship, bridge and tank plates, producers generally want £10 10s. Promising inquiries for future supplies of ship plates are coming forward. Staffordshire hoops are retained at £12 at works, though some rollers continue to ask 5s. more. Steel makers are not making rapid price advances in finished material; but their customers are usually advised that quotations must be accompanied by a time limit. Some steel makers complain that specifications are still scarce, and consider that recent bookings are largely speculative. In some cases the local mills have had to change rolls four or five times a shift. There has been no change in angles, joists and tees, but prices are quite firm. General steel price advances are looked for in the New Year.

Big Demand for Scrap.

The keenness of consumers to secure supplies of scrap is a feature of the market, and holders are encouraged to ask increasing prices for prompt deliveries. The minimum price now quoted is £4 15s. for steel scrap, and many merchants express doubts as to whether any firm would accept this. Sales have been made at £5, and even £5 5s., where users are without supplies. Some well-known Midland works bought with confidence at much lower prices, and are therefore now in a very favourable position. Steel turnings are much in demand, and there is not a great deal of this material to be had, in view of the prolonged slackness in the engineering industry. Iron scrap is also difficult to obtain and is increasing in value. Some few scrap consignments from the Continent have been received, but war scrap has now generally disappeared, and steel makers anticipate that the scarcity of this material will necessitate the use of a larger proportion of pig iron in steel furnaces for the future. The rapid rise in scrap values is much criticised.

Edge Tool Industry.

The edge tool trade of South Staffordshire is, I am pleased to be able to state, in a fairly healthy condition at the moment. Business is brisk, and buyers make continual demands for delivery at short notice. In fact, practically all the business is of this nature. It probably suggests that there has been a long holding off until requirements have become urgent, but buyers have evidently also been induced to contract by the knowledge that steel is not likely to be any cheaper. Edge tool prices are not being advanced, and it is considered that if circumstances do not change, quotations will probably remain the same, in order to attract continuous business. Inquiries are satisfactory all round, but the Indian market is the most healthy just now.

Derbyshire Colliery Developments.

With the object of increasing outputs of coal to meet the growing demand, both for inland use and for export, and of placing pits in a better position to compete with the newer undertakings in the Doncaster district, important developments are being pushed forward in the Derbyshire coalfield. The Staveley Coal and Iron Company has prepared an extensive plan of development, which in the case of the Markham No. 2 Colliery has provided the opportunity of work for an additional 300 men. The haulage plant has been so modernised that a much greater quantity of coal can be brought to the surface. At other two pits of the company, I understand, work will shortly be found for an additional 2000 men. Rapid progress is being made at Markham No. 1 pit in sinking into the black shale, and at Barlborough No. 2 pit the deep soft seam is to be opened up.

Electrical Engineering at Coventry.

I learn that business in the electrical engineering industry at Coventry is likely to be extended in the near future. The large factory in Alma-street, Coventry, formerly occupied by the Dunlop Rubber Company, which has been vacant for some time, has been taken over by a firm of electrical engineers, whose headquarters are at Rugby. The building is being adapted to the production of electrical equipment, in which the full range of radio apparatus will form an important part. Gradually the whole of this work will, it is understood, be transferred to the new premises, where on highly systemised mass production lines the complete articles will be manufactured. Machinery is already installed, and working in some of the shops, and it is hoped that on radio production alone, employment will eventually be found for 1000 hands, and of this number, 30 per cent. should be at work by the middle of January.

Unemployment.

Unemployment in the Midlands continues on its satisfactory downward course, the latest returns showing a further decrease on the week of 2733. The total now stands at 150,630, made up of 109,870 men, 2432 boys, 34,431 women and 3897 girls. To the total, the Birmingham area contributes 37,903, Bilston 3313, Coventry 4326, Cradley Heath 5051, Dudley 4673, Oldbury 1741, Smethwick 4655, Stourbridge and Brierley Hill 3583, Walsall 5313, West Bromwich 2666, and Wolverhampton 7473.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

On the whole it may be admitted that the markets for iron and metals are relieved this week to find that there is to be no fiscal disturbance to trade in the near future. There are, of course, some people who are disappointed and who had been hoping that competition from foreign steel in the home markets would have been checked by a tariff; but the general feeling is one of relief that the tendency towards improvement which has already set in will not be disturbed by a fierce tariff struggle. Last week business was largely held up by the election, but things are beginning to settle down again this week, and although there is not very much activity, yet there is a very strong belief that next year we shall see a revival both in the ferrous and the non-ferrous industries. A period of "tranquillity" may now be hoped for, and this of itself will be good for trade.

Metals.

Merchants engaged in the copper and tin trades do not complain very much now, and it may therefore be assumed that they find it easier to secure business. Some say that they are doing very well, and there is certainly a greater disposition to buy than there was. Very little change has taken place yet in copper prices, and most people admit that they are still comparatively low. The small upward movement which has taken place in refined copper since October is just enough to encourage people to buy for stock and not enough to induce any fear of a collapse. During the whole of last week we had scarcely any change in refined copper prices, and it rather looks as if we should have the same soothing experience this week. This would bring us so near to the end of the year as to make it probable that copper would remain steady for at least another two or three weeks. The American position is perhaps not so steady and sound as it might be, and although there are constant rumours of an endeavour to restrict the output, nothing has yet been done in that direction. It is, however, possible that further combinations are near at hand which will put the producers in a stronger position. At any rate, there is not much probability now of any serious fall in copper prices. Prices for manufactured copper and brass are steady, and are still relatively high compared with the corresponding raw material. So far there has been no movement in the prices for scrap copper and brass, which remain relatively low. The market for tin has been very firm for some time. One or two reactions have taken place, but the general position is thought to be very good. Something, of course, depends upon whether America will be so good a consumer next year as she was this year; but there seems to be no doubt that the demand for tin from the tin-plate makers is likely to be large, and in the present condition of supply this seems sufficient to uphold the market, unless speculative influences should drive prices up unduly. The market for lead has shown a little ease, but there is still a scarcity of spot metal. To most people the prices appear dangerously high; but it has to be remembered that consumption of lead has increased during the last ten years without any corresponding increase in the world supply. Spelter has been a steady market, although it is said that there is rather more metal.

Pig Iron.

The Manchester market for foundry iron is quiet and a little dull at the moment, but there is no sign of any weakening in the prices. On the contrary, the general idea is that foundry iron prices will be rather higher next month, unless too many idle furnaces are brought into action. Of this there does not seem to be any great probability, because pig iron production is not a very profitable occupation at the present time, owing to the excessive cost of fuel. There might possibly be some reduction in blast-furnace coke if the French are successful in getting the industries of the German Black Country into order again; but this is too uncertain to be relied upon. The furnaces suitable for the supply of iron to the Manchester founders are all fairly well sold for the present, and the tendency is to ask rather higher prices for far forward delivery. The prompt price for Derbyshire iron is now usually based on 95s. per ton at the Derbyshire furnaces, or, say, from 102s. 6d. to 103s. 3d. per ton delivered in Manchester; but some sellers are prepared to accept a little less for December and January delivery. The usual price now quoted for Scotch iron in Manchester is 125s. per ton, and for some brands up to 127s. 6d. It is said that rather more Scotch iron has been sold here lately, but for all ordinary foundry work the cost is too high. The demand for forge iron seems a little better.

Steel.

The "fixed" price for sectional steel was no kept fixed for very long. In fact, one did not see very well how a "fixed" price below the average cost of production could be of much service to the trade. This price has now been raised by 10s., and the limit is now £10 per ton for joists and large angles in Lancashire and £10 5s. in Cheshire. The market for steel plates is also firmer, and £10 10s. per ton seems to be the idea here. Merchants have control of some supplies at considerably less, but they naturally quote about the same as the selling agents or manufacturers. It seems to be expected that a further advance in plates will come with the New Year. The market for finished iron is better than it was, and more

orders for bar iron are being placed in Lancashire. As a result the Bar Iron Association is now asking £12 10s. per ton for Crown quality.

Scrap.

The market for steel scrap is again very strong and there is a decided scarcity in the supply. Large inquiries for heavy steel melting scrap have been heard of, one being for 4000 tons, but that was up in the North. Sheffield consumers are, however, more anxious to buy, and this is more interesting to the Lancashire dealer. Somewhere about 90s. per ton seems to be the idea of dealers here at the moment. Heavy wrought scrap is also inquired for, and the market is firm at from 95s. to 97s. 6d. per ton. Cast scrap is not so much inquired for, but the feeling in the market is decidedly better than it was. Dealers, where not compelled to realise, are disposed to hold back until next year, for it is believed that then the Lancashire ironfounders will be ready to buy much more freely. For fine broken machinery metal dealers now ask 92s. 6d. per ton, but there are still opportunities to buy good cast scrap at less than this.

Barrow-in-Furness, Thursday.

Hematite.

The improved state of the hematite pig iron trade is maintained, but the amount of business being done at the present time does not amount to much, comparatively speaking. There are abundant signs of the presence of more confidence, but the business is not improving at a rapid rate by any means. When we come to the turn of the year there is every likelihood of the trade becoming better and demanding the putting in of more furnaces. The steel departments in the district are taking a considerable amount of the output, and from all the signs are likely to for some time, and this will be an additional reason for increasing the output if trade improves much. The home trade is the best, and the Midlands and Scotland are improving as time goes on. A fair amount of pig iron is going to Wales and there are shipments of ingot moulds as well. Neither the Continent nor America is a large customer at present, although regular, but small cargoes or part cargoes go to Ghent and other continental ports. The amount of business done in special qualities of iron is fair, but this trade will improve. Charcoal iron is finding a fair market. Prices all round are still showing a tendency to rise, and this is a sign of better trade. There is not much booking of forward deliveries as yet.

Iron Ore.

The iron ore trade remains about the same as it was last week. It is not brisk and awaits the increase in the number of furnaces before there is anything like activity. There is not much going out of the district as yet. As regards foreign ore, this is only in moderate demand owing to the number of furnaces in blast. Shipments of Spanish ore to West Coast ports in the past having exceeded requirements, have caused stocks to accumulate at docks, and these have to be cleared first.

Steel.

The steel trade is fairly well employed, and there is a better feeling of confidence about. The rail mills at Barrow and Workington are engaged and there are more orders to follow in due course. There is more activity in this department than there has been for some time. The merchant mills at Barrow are employed and the hoop and section mills are well situated for business.

Engineering and Shipbuilding.

There is hope now that the boilermakers' dispute is at an end, that contracts held at Barrow will be pushed on with, and already there are many men employed in the boiler shops and on the stocks. Further than this, now that the air is clearer, firms are in a better position to deal with prospective customers, and there is some chance of further contracts being booked in the early future. It will not be long before the firms are requested to tender for the several cruisers which the Admiralty has decided to build, and Barrow should fare well in this distribution of work.

SHEFFIELD.

(From our own Correspondent.)

The Improving Steel Trade.

The progress of the steel trade continues, and is noticeable on both the heavy and the light sides. It is not as fast as could be desired, as the individual orders being given out are for the most part on a small scale. However, the tendency is in the right direction. A big tonnage of basic steel is being turned out every week by the United Steel and other local companies, although their plants are not working at full capacity. Substantial business is being booked by the makers of wire ropes. An improving branch of the tool trade is that which provides files, but, although the demand is better, there is little or no profit to be made, owing to the keen competition. Various engineers' requisites are in better request, and considerable work is now on hand at some of the foundries outside Sheffield. The motor trade of Birmingham and other centres continues to make a very useful call for Sheffield alloy steel. During the last few weeks there has been a greatly improved demand for bar iron, the price of which went up 10s. last week.

A Good Colliery Contract.

A good order reported this week is one secured by the Brightside Foundry and Engineering Company, Limited, for a complete simultaneous decking installation for one of the large local collieries. The firm is just completing a similar plant for the New Sharlston Colliery Company, and the new order will enable it to find full employment for a considerable time for the department which is engaged in this class of engineering. The contract price is several thousand pounds. When completed, the installation will be the most up to date of its kind, having several devices introduced which, while they may have been used for other colliery plant, have not been used before for decking machinery.

Local Firm's Indian Interests.

An interesting matter with regard to the Sheffield steel trade's connection with India has been referred to in the course of evidence given before the Indian Tariff Board on the subject of the proposed increase of the duty on imported steel to 33⅓ per cent. Mr. Tarlton, of Bird and Co., one of the supporters of the proposal, stated that his firm, in conjunction with Cammell Laird and Co., Limited, had instituted a scheme for organising the United Steel Corporation of Asia, with a capital of £20,000,000. The works would eventually have an annual output of 450,000 tons of rolled steel, besides pig iron, ferro-manganese, ores, coal, coke and by-products. Mr. Tarlton said that he thought India was destined to occupy a position of the greatest importance in the world of steel, as there was abundance of iron ore, cheap fuel, cheap labour and other favourable factors.

A Lincolnshire Colliery Enterprise.

The opening up of what used to be called the "concealed" coalfield continues in a more and more easterly direction. The sinkings and borings in Nottinghamshire have gradually approached the border of Lincolnshire, and now comes news of a project actually within the latter county itself, at a place called Doddington, about midway between Retford and Lincoln. Doddington at present is a small village with a population of about 240, and is one of the prettiest spots in the county. The experts believe that the seam of the Midland coalfield exists there, and this belief is strengthened by the results of the boring at Retford, Leverton and other places in the district. Doddington is well within the area indicated by Professor Kendall's report to the Royal Commission on Coal Supply in 1904. The boring is to be carried out by the Lincolnshire Boring Syndicate, Limited, a company formed at Doncaster, which has acquired nearly 5000 acres of land in the Doddington neighbourhood. The boring is expected to be completed in twelve or fifteen months, and it is thought that coal will be struck at a depth of 900 to 1000 yards. The work will be under the supervision of Mr. J. Ford, of Doncaster. The enterprise is attracting great interest, not only in its own immediate vicinity, but also among the manufacturing firms of Lincoln, which is only 6 miles distant. While on the subject of colliery developments, a reference may be made to Harworth, where coal has been found in both shafts, and the work is proceeding rapidly. The Nottinghamshire County Council has given notice that it proposes to provide a new public elementary school for about 600 children in the parish of Harworth.

Empire Exhibition Cutlery.

An exceptionally valuable order for table plate and cutlery has been placed with a local firm. It has been given out by Messrs. Lyons, the caterers for the British Empire Exhibition, and is for the equipment of the various refreshment rooms at that great undertaking. The value of the order, it is reported, will run well into five figures. The general trade in plate and cutlery is now tapering off. The special season orders are practically completed, with the exception of late requests for oddments. There has been a good demand during most of the year for spoons and forks, including those made of sterling silver, but hollow-ware, alike of silver and of best plate, has been, and continues to be, a weak side of the trade. A very large trade continues to be done in unplated spoons and forks. The demand for stainless table cutlery is well maintained, but it is very noteworthy that the Corporation on three recent occasions, in making presentations of Sheffield cutlery, has given knives of shear steel instead of stainless. The latest instance of this kind was the cabinet of cutlery presented to the Right Hon. S. M. Bruce, Prime Minister of Australia, when he visited Sheffield last week to receive the freedom of the city.

Cheaper Gas and Electricity.

Reductions in the price of both gas and electricity, which are largely used in Sheffield for power as well as lighting and heating purposes, are announced this week. The Gas Company will, from the meter readings for the December quarter accounts, put into force reductions of one-fifth of a penny per therm in the various scales, with the exception of the highest, in which the reduction is two-fifths of a penny. This is the third reduction in the price of gas this year, and will bring the rates down to the following:—3s. per 1000 cubic feet for quantities up to 500 therms per annum; 2s. 4d. per 1000ft. up to 2500 therms; 2s. 3d. per 1000ft. up to 15,000 therms; 2s. 2d. per 1000ft. up to 30,000 therms; and 1s. 11d. per 1000ft. for quantities in excess of this. The Electricity Supply Committee of the City Council recommends that the charges for electricity on all units, including traction, charged at 2d. per unit or under be reduced as from the December readings from 50 to 40 per cent. on the basic rate, and the charges on all units at over 2d. per unit from 25 to 20 per cent. on the basic rate.

Sheffield Work Schemes.

Among the schemes which the Finance Committee of the Sheffield City Council has approved this month as relief works are the supply of twenty-five double-deck top-covered tramcars, with the necessary electrical equipment, estimated to cost £54,375; widening of Penistone-road between High Bridge and Leppings-lane, at a cost of £15,000; street and sewer works at High Storrs estate, at a cost of £7148. The Committee also urges that the laying of an extra high-tension feeder cable from Fulwood to Millhouses, at a cost of £13,545, be carried out as soon as possible. The Tramways Committee has accepted a tender from Cammell Laird and Co., Limited, for 500 steel tramcar tires, at the rate of 61s. 9d. each.

NORTH OF ENGLAND.

(From our own Correspondent.)

Improved Trade Outlook.

Despite the disturbed political situation, there has been an appreciable, though not very considerable, improvement in the trade position in the North of England this week, and traders generally are inclined to take a cheerful view of the outlook. The gradual resumption of operations at the shipyards has already begun to influence new business in the iron and steel trades, and as a result of the brighter prospects, two more blast-furnaces have been started this week on Tees-side. This brings the number of blast-furnaces in operation on the North-East Coast to forty-six, of which fourteen are producing Cleveland pig iron, sixteen hematite, and sixteen special kinds of iron. Preparations are also being made to put several other furnaces into blast early in the New Year.

Cleveland Iron Trade.

Notwithstanding the near approach of the Christmas holidays, there is quite a healthy tone about the Cleveland pig iron market. There is no great rush of orders, but a steady demand, and that, after all, is the best condition. Sudden rushes are not wanted. A steady flow of orders to ensure continuity of working is infinitely more desirable, and that is the present state of affairs. It is true that foreign business is not so active, but the home demand continues strong, and there is every prospect of further expansion. There is now a little more No. 1 Cleveland foundry iron on offer, and the price is easier at 106s. 6d., but other qualities are steady, No. 3 being 100s., No. 4 foundry 97s. 6d., and No. 4 forge 96s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is distinctly encouraging. Steel makers, particularly in the Sheffield district, have been buying pretty freely, and there is now not a great deal of prompt iron about. Makers are well booked up, not only for December, but also for the early part of the New Year, and whereas 101s. 6d. and 102s. was quoted last week, there are now no sellers of mixed numbers below 102s. 6d. per ton, either for prompt or forward delivery, and 103s. 6d. is asked for No. 1 quality.

Iron-making Materials.

Deliveries of foreign ore this month have been on a very heavy scale, and new business is quiet at the moment. The recent advance in price, however, has been well maintained, and best Rubio ore is steady at 24s. 6d. per ton, c.i.f. Tees. The supply of coke is none too plentiful. Consumption is on a larger scale, and prices keep firm, good Durham furnace kinds commanding 38s. 6d. to 39s. per ton delivered at the works.

Manufactured Iron and Steel.

A gradual improvement is also to be noted in the manufactured iron and steel trade, and more plant is being put into operation at several works. The effects of steel price control have speedily become apparent in a general advance of 10s. per ton in the quotations for plates, angles and joists. However, previous quotations left little margin of profit, and this small advance is held to be justified by the increased activity of the trade and the high costs of production. It has not appreciably limited the demand for plates and sections, and the rail trade is also reported to be active. There is less inquiry for galvanised sheets, but makers have healthy order books.

The Coal Trade.

The Northern coal trade has experienced a panicky feeling during the past few days, but it is subsiding, and the position is gradually assuming the normal, with prices moving forward to the level of recent quotations. Second-hand men are now inclined to move more cautiously, and refrain from unloading supplies in large quantities, which was the cause of the slump in prices at the end of last week. The export section of the trade, however, still keeps quiet, and there is no great demand—at least, of a pressing nature. German buying is curtailed. In the case of France there is not much business in circulation, while there are reports of some heavy cancelments of Durham gas and coking coals by exporters who had contracted for shipment to France early next year. The quantities involved so far are not calculated to influence the course of the market as yet, but if this movement were continued for any length of time there would be a reaction very soon. The cause stated is that the output of the Ruhr is rapidly expanding. Against this there is said to be a much heavier inquiry and dispatch of Durham coals to the London area, so that the position generally is unaffected. An interesting item this week is the placing of a contract by the Bordeaux gasworks, France, with a Newcastle firm of exporters for 6000 tons of second Durham gas coals for shipment during January. The actual c.i.f. price has not been divulged, but it is said to be in close harmony with current values. The placing of this order has given great satisfaction on the Northern market, owing to the fact that the competition from American exporters is exceptionally keen, and it may be recalled that they were successful in capturing this business several times lately. The Northumberland steam coal position is much better than it was in the closing days of last week. Second-hand men are not so anxious to press supplies forward, while the demand is, if anything, slightly fuller. The value of best screened steams is 24s. 6d. as a minimum for prompt and rather higher for January onwards, with secondary screened sorts also slightly better, and small steams moderately firm at higher prices. The Durham market is steadier, and for all classes and grades there is a good demand and a consistent tendency to improve. Gas coals are in heavy request, and for special brands as well as prime sorts top figures are indicated, with secondary sorts also inclined to rise. Coking coals are scarce and difficult to obtain. Foundry coke is plentiful, and is appreciably easier in price, while gas coke is more or less quiet and a shade lower.

SCOTLAND.

(From our own Correspondent.)

A Quieter Week.

DURING the past week or two business has been a somewhat secondary consideration owing to the political situation, and this was manifest up to the declaration of the results. The uncertainty of the position at present is having some effect also, but attention is once more directed to the ordinary things of the day. Markets have remained firm and indicate further appreciation in most products. The outlook for next year is comparatively bright meantime, and provided conditions remain quiet politically and industrially, hopes of improvement will probably be realised.

East Coast Shipbuilding.

The settlement of the shipyard dispute has had an almost immediate effect on the industry at Burntisland. As in other places, activities there had been much reduced, only about 350 workers, including apprentices, being employed. The Burntisland Shipbuilding Company, however, has enough work in hand to cover the most of next year, and in a very short time upwards of 1000 persons will be employed. At present four cargo ships are on the stocks, averaging 3000 to 4000 tons and of a high specification, and several other orders are on hand. Workers who left during the slackness are now trooping back to this district.

Pig Iron.

Business in pig iron is quieter, but the market records further advances in prices. Buying is chiefly against future requirements, and consumers show continued inclination to cover fairly well ahead even at present quotations. Supplies are not too plentiful, however, and makers are not disposed towards extensive contracts in the meantime. Inquiries are chiefly for home delivery, the export demand being rather meagre at present.

Busier Ironworks.

The position of the bar iron works is more satisfactory. Makers have now more work on hand than has been the case for a considerable time. Specifications are now coming through in connection with shipyard work, and demands from railway companies and wagon builders are increasing. The basis price is unchanged so far, but an increase is still anticipated. The re-rolled steel department is sharing in the increased turnover.

Dearer Steel.

Scottish steel prices have been advanced by 10s. per ton, the new minimum basis quotations being now as follows:—Ship plates, ¼in. and up, £10 5s.; sections, £10; joists, £10 per ton. The output from the steel works is still below normal, but an improvement is noticeable, inquiries being on the increase for plates and sections. Steel sheet makers remain well placed. Both heavy and light sheets are well bought for home and export, and galvanisers have a good turnover in flat and corrugated varieties. Export has not been quite so busy, but home demands are steady.

Cheap American Prices.

In tendering for special steel rails for the Glasgow Corporation Tramways the quotation submitted by the United States Steel Products Company was found to be the lowest, its price being £8568. The nearest British price was the £9794 submitted by Hadfields, Limited.

Firm Coal Prices.

Although new export business in coal is scarce the collieries maintain a very firm position, with prices still on the upgrade. The bulk of the output is already accounted for until the end of the year, and any odd lots becoming available are securing even higher prices than those quoted in the price list which are named for forward delivery mostly. West of Scotland ells, splints, and steams, Lothians and Fifeshire first and second quality steams all incline upward, while washed materials in all districts are stronger. Shipments from the West of Scotland and the Lothians are fairly prompt, but considerable delays are experienced at Fifeshire ports, where the loading turn is one of ten days to a fortnight. Aggregate shipments during the past week amounted to 292,346 tons against 287,958 tons in the preceding week and 331,689 tons in the same week last year. The home market is improving owing to better demands for industrial fuel. General utility deliveries are very heavy at present. It has been stated that it is understood that the London, Midland and Scottish Railway Company—Caledonian section—has fixed a contract for about 1,000,000 tons of coal with a West of Scotland coal company for delivery between January 1st and December 31st next year. The price is said to be a little in advance of present contract rates.

Miners' Agreement.—Scotch Demand for Modification.

Unless the present wages agreement in operation in the mining industry is satisfactorily modified the Scottish miners will ask the British Miners' Federation to give three months' notice to terminate the agreement. This decision was reached at a meeting of the Scottish Miners' Executive, when five delegates were appointed to attend a national delegate conference of the Federation this week.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THERE has been no appreciable change in the general state of the coal trade, or of its outlook as compared with a week ago. Business is rather quieter if anything, and that for the reason that stems are so tight. Operations have practically come to a standstill for this month's shipment, and so far as buying ahead is concerned continental consumers do not appear at all anxious to come along at the present prices which are being indicated for delivery early in the New Year. The loss of practically a week's output this month is calculated to keep the market firm well into January. At the moment, it has not been definitely decided what holiday the miners will have at Christmas time, though they have intimated that their application is for three days, viz., Monday, Tuesday and Wednesday, which will probably be agreed to by the owners when the subject comes before the Conciliation Board for discussion.

The Third Shift.

The question of the third shift as it affects Cardiff, Penarth and Barry, has been the subject of a good deal of discussion in local coal trade circles during the past week. The extra shift is being continued at all ports in the Channel with the exception of Cardiff, Penarth and Barry, and despite the instructions from headquarters which the tippers received last week, these men decided during last week-end not to work the shift. There were further meetings on Monday, and in the afternoon a joint conference with the employers' representatives took place, at which the latter placed before the men's leaders the seriousness of the position. As a matter of fact, there have been as many as forty to forty-five steamers waiting in the Channel for loading berths this week. However, the outcome of the joint conference was that the trimmers and tippers were recommended to resume the partial third shift immediately and until January 5th, when it should be discontinued failing an agreement between the employers' and workmen's representatives. An appeal was made to the men to resume the extra shift not later than Wednesday of this week. The tippers at Cardiff and Penarth held sectional meetings on Tuesday and agreed to resume the shift, but the Barry men are holding out. They asked that there should be another mass meeting of the tippers and trimmers on Sunday next to consider the position; but having heard the decision of the Cardiff and Penarth men it is not unlikely that before the end of the week they will fall into line.

LATER.

Barry tippers decided to fall into line, and as a result the working of the partial third shift was resumed at Cardiff, Penarth and Barry on Wednesday night. There were seventy-eight vessels waiting for loading berths at Welsh ports on Wednesday. The employers have now definitely decided to refer the question of the third shift back to the adjourned Industrial Court, as the men have only agreed to continue it until January 5th, failing mutual agreement in the meantime.

Miners and Wages Agreement.

Two important subjects came before a special conference of the South Wales Miners' Federation at Cardiff on Monday, one being the general wage negotiations and the other concerning the fixing of the rates of wages for the workmen affected by the introduction of coal-cutting and conveying machinery. With regard to the former the concensus of opinion was that the most effective way to deal with the position was to end the present arrangement, and the unanimous decision was come to that the South Wales delegates to the National Miners' Conference on Friday of this week should be instructed to vote in favour of terminating the present wage agreement. On the question of machine mining and conveyor systems, the conference decided to refer the whole matter back to the lodges. It was pointed out that the most definite proposal formulated by the Council was that when a conveyor or coal cutter is introduced, until such time as a price list is agreed to, the workmen employed thereon shall be paid not less than 3s. 4d. per shift net above the minimum, and that in each case a special effort shall be made to get a price list established within three months. In the meantime, the workmen should perform a fair day's work for the above wage.

Loading Hours.

Negotiations have been in progress for some time between the various interests, but matters have now come to a head, and the South Wales Coalowners' Association has adopted a recommendation from its Commercial Committee that the hours in the standard form of South Wales Coal Contract shall be as follows at ports in this district where the third shift is in operation and is actually worked:—Six hours per 100 tons for the first 1000 tons, viz., 60 hours; four hours per 100 tons for the next 1000 tons, and 2½ hours per 100 tons afterwards. No steamer's loading time is to be less than 60 hours. The scale will, therefore, be 1000 tons, 60 hours; 2000 tons, 100 hours; 3000 tons, 125 hours; 4000 tons, 150 hours; 5000 tons 175 hours; 6000 tons, 200 hours, and 7000 tons, 225 hours. The question of loading hours will continue to be a matter for negotiation and arrangement between merchant and shipowner, but the above scale will apply when "colliery scale" hours are referred to or are inserted in charter.

Tin-plate Dispute.

The dispute referred to in my previous letter, which resulted in the fitters and smiths in the tin-plate industry in the Neath and Briton Ferry district going on strike, was settled before the end of last week, as the result of a conference between the officials of the unions concerned and the representatives of the men. The men's grievances will be dealt with at the next meeting of the Joint Industrial Council for the trade.

Docks Appliances.

The announcement is made that the Great Western Railway Company is providing eighteen new tips to accommodate wagons of 20 tons capacity at South Wales ports in addition to nineteen now being erected. At Cardiff East Dock five new cranes, for dealing with merchandise traffic, are to be provided, and the tender of Simons and Co. for a floating pneumatic grain-handling plant at Cardiff has been accepted. At Swansea King's Dock, nine 5-ton quick-acting hydraulic cranes are to be provided for the quick handling of mineral and merchandise traffic.

Current Business.

The tone of the steam coal market has been firm on the whole, though not quite as strong as might have been the case had collieries been able to secure the clearance of coals they desired. The position of many collieries has been prejudiced by the fact that the third shift has not been worked at Cardiff, Penarth and Barry, and this has meant that the shipment of coals has been held up, and there has been a shortage of wagons. Collieries are, however, well stemmed for the remainder of this month and the early part of next, and except for possible small parcels they really have no coals to spare. Best Admiralty large are round about 30s., and second qualities 28s. 6d. while superior smalls command 22s. Coking smalls are still very scarce. Patent fuel is firmer on account of the advance which has taken place in small coals. Coke remains good, and as regards anthracite coals the market is fairly steady all round without any notable change in values.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WELDRICS (1922), Limited, of Bush-lane House, Cannon-street, London E.C. 4, informs us that it has purchased the business of Messrs. T. Scott Anderson, electrical welding engineers and equipment manufacturers, of Royal Insurance Buildings, Church-street, Sheffield, and is continuing those offices as a branch establishment.

BRITISH PHOTROMS, Limited, informs us that owing to increase of staff it has secured more commodious office accommodation on the first floor of Abbey House, 2, 4, 6 and 8, Victoria-street, Westminster, S.W., and hopes to move in on or about the 15th inst. Its business address and telephone number will, however, remain as heretofore.

WE are asked to state that Mr. A. J. Rayment, head of the technological books department at Sir Isaac Pitman and Sons, Limited, is severing his connection with that firm at the end of the year. Mr. Rayment requests that, pending other arrangements, any communications of a personal character may be sent to him c/o Theodore Stevens, M. Inst. C.E., 50, Lincoln's Inn-fields, W.C. 2.

WE are asked to state that Mr. A. E. Ingham, A.M.I. Mech. E., manager to the Manchester branch of the Associated British Machine Tool Makers, Limited, has resigned his appointment to take up a position at the works of Geo. Richards and Co., Limited, Broadheath. Mr. Lund, manager to the Leeds branch of the Associated British Machine Tool Makers, Limited, has been appointed Mr. Ingham's successor at the Manchester office, Lloyd's Bank Buildings, King-street, Manchester.

CONTRACTS.

OZONAIR, Limited, of 96, Victoria-street, London, S.W. 1, has just completed or has in hand installations of its system of pure air ventilation in three large West End London shops; two underground conveniences; a public fruit sales room; a bank premises; and in a large emporium in Brussels.

THE Swiss Federal Railways have ordered from Sulzer Bros., of Winterthur, for delivery next year, a "Sulzer" Diesel rail-car, which will be driven by an eight-cylinder 250 brake horse-power engine. The length over buffers is to be 65ft., the gross weight 55 tons, and seating accommodation for 50 passengers in two compartments is to be provided.

THE Hellenic Government has placed a contract with J. Samuel White and Co., Limited, of Cowes, for supplying and installing new boilers and boiler-room auxiliaries, completely overhauling the machinery, and also carrying out considerable structural alterations to the hulls, including reconstructing the bunkers for carrying oil fuel instead of coal, in connection with the four destroyers Ætos, Ierax, Panther and Leon. The contract for supplying and fitting additional armament, including gun control fittings of the latest pattern, has been placed with Vickers Limited. The destroyers are now on their way to Cowes.

INSTITUTION OF MECHANICAL ENGINEERS.—The annual dinner of the North-Western Branch of the Institution of Mechanical Engineers was held last Friday, the 7th inst., at the Engineers' Club, Manchester. There was a large attendance of members and friends, presided over by Mr. Alfred Saxon, chairman of the Branch, who was supported by Sir Holberry Mensforth, Mr. John Taylor (President of the Club), Mr. Clare Lees (President of the Manchester Chamber of Commerce), Mr. G. A. Juhlin (Chairman of the North-Western Section of the Institution of Electrical Engineers), and members of the Committee of the local branch of the Institution. In proposing the toast of the "Local Industries," Sir H. Mensforth said that there was no industry in the country which had greater liabilities than that of engineering. It had, in the first place, the responsibility of its own production as well as that of providing the means of production for nearly every other industry in the country. That responsibility was great, and engineers had to realise the traditions which had been handed down to them. Was the industry going to add to them or live on them? He suggested that labour was entitled to ask from the controllers of modern industry that their control should be efficient, and it was necessary for the younger generation to equip themselves accordingly. There should be no secrets in the running of an industrial concern. Engineers could save any amount of money which was wasted on industry without making an attack on wages. There was not half enough propaganda among the employers. It was no use objecting to the doctrines which those whom they employed were assimilating. Let them put some other doctrine before them. He was satisfied from his knowledge of things that if engineers in Lancashire would learn what the men in the past, who built up its reputation for heavy engineering, textile machinery, locomotives, tool making and cotton spinning, had taught, they need have no fear as to the future of the engineering industry. Mr. Clare Lees, replying to the toast, said that the two main industries of the district were engineering and cotton, and although they were both suffering from unemployment, the causes were fundamentally different, and the methods and cures for them rested upon entirely different factors. Mr. John Taylor also replied to the toast, and advocated the formation of workshop committees as a means of increasing production. Mr. Juhlin proposed the toast of "The Institution of Mechanical Engineers," which was replied to by Mr. Daniel Adamson. The toast of "Our Guests" was proposed by Mr. Joseph Butterworth, and responded to by Mr. Oliver Stubbs, who made an appeal to those present for their support of the work of the Cast Iron Research Association.

Current Prices for Metals and Fuels

IRON ORE.

N.W. COAST—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 8 9	—
No. 1 Foundry	5 11 3	—
No 3 Foundry	5 6 3	—
N.E. COAST—		
Hematite Mixed Nos.	5 2 6	5 2 6
No. 1	5 3 6	5 3 6
Cleveland—		
No. 1	5 6 6	5 6 6
Silicious Iron	5 6 6	5 6 6
No. 3 G.M.B.	5 0 0	5 0 0
No. 4 Foundry	4 18 0	4 18 0
No. 4 Forge	4 17 0	4 17 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 10 0	—
„ „ Foundry	4 15 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 13 6	—
„ Forge	4 7 6	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0	—
Forge	4 9 0 to 4 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 15 6	—
No. 4 Forge	4 14 0	—
Basic	4 15 0	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 15 0 (*a*) / 6 0 0 (*b*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best „	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 5 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 17 6 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 0 0	—
Joists	10 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light „	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Hoops	14 10 0	—
MANCHESTER—		
Bars (Round)	10 10 0 to 10 15 0	
„ (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0	—
„ (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	9 0 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
MIDLANDS—		
Small Rolled Bars	10 10 0 to 11 0 0	
Billets and Sheet-bars	8 7 6 to 8 15 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	19 0 0 to 19 5 0	
Angles	9 15 0	—
Joists	9 15 0	—
Tees	10 15 0	—
Bridge and Tank Plates	10 0 0 to 10 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/9 to 24/3
Block Tin (cash)	229 10 0
„ (three months)	230 15 0
Copper (cash)	62 7 6
„ (three months)	63 2 6
Spanish Lead (cash)	31 5 0
„ (three months)	29 11 6
Spelter (cash)	32 6 3
„ (three months)	32 13 9
MANCHESTER—	
Copper, Best Selected Ingots	66 10 0
„ Electrolytic	68 0 0
„ Strong Sheets	95 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	33 0 0
„ Foreign	31 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£22 0 0	8/-
„ 8 p.c. to 10 p.c. „	£21 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£65 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 6/- per unit	
„ Vanadium	20/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£120	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

	Export
SCOTLAND.	
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	23/6
„ „ Ell	25/-
„ „ Splint	25/- to 28/-
„ „ Trebles	24/9
„ „ Doubles	23/-
„ „ Singles	21/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	23/6
„ „ Splint	25/-
„ „ Trebles	24/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	21/9 to 24/-
Screened Navigation	28/-
Trebles	26/- to 27/-
Doubles	23/-
Singles	21/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	24/6
Secondary Steam	23/-
Trebles	25/3
Doubles	23/3
Singles	21/3
ENGLAND.	
(8) N.W. COAST—	
Steams	29/-
Household	48/- to 59/-
Coke	43/6
NORTHUMBERLAND—	
Best Steams	24/3 to 25/6
Second Steams	21/6 to 23/-
Steam Smalls	14/6 to 16/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 25/-
Second „	23/- to 23/6
Household	25/- to 28/-
Foundry Coke	50/-
SHEFFIELD	Inland.
Best Hand-picked Branch	33/- to 34/- —
Barnsley Best Silkstone	27/6 to 29/- —
Derbyshire Best Brights	27/- to 29/- —
„ „ House	23/- to 24/- —
„ „ Large Nuts	22/- to 23/6 —
„ „ Small „	17/6 to 19/6 —
Yorkshire Hards	22/- to 23/6 —
Derbyshire „	21/- to 22/6 —
Rough Slacks	12/6 to 13/6 —
Nutty „	10/- to 12/- —
Smalls	5/- to 8/- —
Blast-furnace Coke (Inland)	26/- to 27/-
„ (Export) f.o.b.	32/- to 33/
CARDIFF— (9) SOUTH WALES.	
Steam Coals:	
Best Smokeless Large	29/6 to 30/6
Second „ „	28/6 to 29/6
Best Dry Large	26/- to 29/-
Ordinary Dry Large	26/- to 28/-
Best Black Vein Large	28/6 to 29/-
Western Valley „	27/6 to 28/6
Best Eastern Valley Large	27/6 to 28/6
Ordinary „ „	26/- to 27/-
Best Steam Smalls	21/6 to 22/6
Ordinary „	18/- to 21/-
Washed Nuts	30/- to 31/-
No. 3 Rhondda Large	29/- to 30/-
„ „ Smalls	25/- to 26/-
No. 2 „ Large	24/- to 25/-
„ „ Through	20/- to 22/-
„ „ Smalls	19/- to 20/-
Coke (export)	52/6 to 60/-
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	31/6 to 32/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 45/-
Seconds	34/- to 36/-
Red Vein	32/- to 33/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 57/6
Beans	42/6 to 45/-
Peas	26/- to 27/-
Breaker Duff	12/9 to 13/-
Rubbly Culm	13/- to 14/-
Steam Coals:	
Large	24/- to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovet and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (*a*) Delivered Sheffield or Glasgow. (*b*) Delivered Birmingham.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Trade Reconstruction.

THE rejection of the Protectionist programme in Great Britain has given satisfaction to the French, who, nevertheless, find that the situation has been complicated by the turn events have taken, and they congratulate themselves upon the settlement of the Ruhr problem before anything could be done to create embarrassment. Now that agreements have been signed by firms in the Ruhr to carry on work under normal conditions, and continue deliveries for reparation, the way is regarded as being opened up for a policy of general trade reconstruction. The French are sincerely anxious to secure the collaboration of Great Britain in making the most of the economic victory over the Germans in the Ruhr, and after going through anxious times, when it appeared likely that the British market would be lost to continental producers, this country would readily co-operate with Great Britain in any programme of financial and industrial reconstruction on condition that the Ruhr policy is not called into question. It is understood that the French Government has already a programme which will be submitted to the new British Government. The idea is to bring the British round to the French point of view by showing that British manufacturers can benefit largely from a policy which aims at a general revival of commercial and industrial activity.

Benzol from Peat.

Private research in the carbonisation of peat at low temperatures is giving results that promise the development of an industry which will provide the country with all the benzol it may need for generations to come. It is claimed that laboratory experiments carried out for two years past have completely changed the aspect of the peat problem, which has been entirely neglected in favour of alcohol and other fuel products in the belief that the cost of treating peat would be more than the value of the products recovered; but the results obtained with the carbonisation of peat at low temperatures are so far satisfactory that arrangements are now being made to develop the system on a commercial scale. The success depends upon the desiccation of the peat, which is effected rapidly and cheaply by reducing it to a coarse granulated form, so that the greatest possible surface is exposed to the heat. A close investigation into the characteristics of peat shows that a large proportion of water is contained in minute globules which merely deform under the strongest pressure without releasing the water. Systems for drying peat under pressure are, therefore, regarded as illusory, and it is obvious that artificial heat can only be applied to particles, so that the operation of drying and carbonisation at low temperature may be continuous. The products comprise at least 25 per cent. of benzol, the rest consisting of light and heavy oils, tar, phenol and residues, as well as solid granulated carbon fuel of from 5000 to 6000 calories per kilogramme—say, from 9000 to 10,800 B.Th.U. per pound—with a very small percentage of ash. The next few months will probably show whether the laboratory experience will give the industrial results expected. It is argued that the peat deposits will allow of sufficient quantities of cheap benzol being produced to render the country independent of imported oil fuels. The system can be applied to lignites and coal of low calorific value, of which there are considerable quantities in this country.

Oil Engineering.

The creation of a special class of oil engineers is being undertaken by the Comité Scientifique du Pétrole, which has decided to establish a school at the Faculty of Strasburg for engineers who may be called upon to take charge of oil enterprises at home and abroad. Subsidies will also be granted to other schools where the geological, chemical and other instruction has a direct bearing upon the oil industry. It is hoped to create an important laboratory for the carrying out of experimental and research work on behalf of those interested in the production and treatment of oils, while arrangements will be made to centralise the results obtained by the various laboratories throughout the country. So much depends upon the home and colonial production of oil fuel that every encouragement is to be given to the training of a class of specialists whose services may be needed in the early future.

Reconstruction.

An official statement of the reconstruction work carried out in the devastated regions shows that out of 22,900 works and factories destroyed or damaged during the war, no fewer than 20,000 have been re-built, and as they are nearly all enlarged and equipped with modern plant the present capacity of the industrial district which suffered from the hostilities is far greater than it ever was before. Close upon 600,000 houses have been repaired, and 143,000 have still to be re-built. Altogether, close upon 100 milliard francs have been spent upon the work of reconstruction.

Electric Locomotives.

As soon as the electrification of the line between Paris and Vierzon is completed, probably by May next, various types of express locomotives will be tested, including one by the General Electric Company of America, which, on a trial run, is said to have attained a speed of close upon 100 miles an hour. The normal speed of the electric expresses is to be from 60 to 70 miles an hour. Locomotives will also be supplied for trial by the Société Alsacienne, the Compagnie Electro-Mécanique, and by some foreign companies. When the Paris-Orleans Company has definitely decided upon the type of locomotive to be adopted, arrangements will be made for its construction by the firms belonging to the Société d'Etudes—that is to say, Schneider and Cie, Thomson-Houston, and the Ateliers de Constructions Electriques du Nord et de l'Est. Meanwhile, orders for a number of electric locomotives have been given out by the Midi Company.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

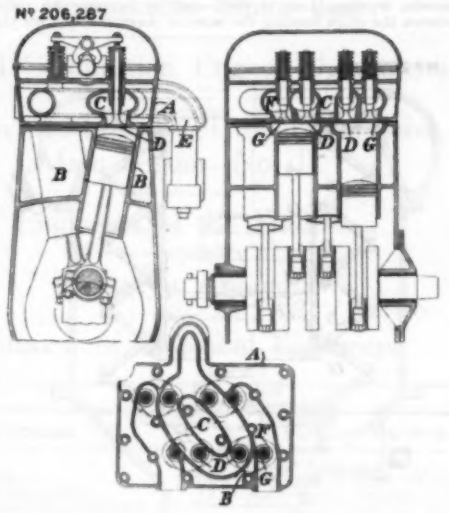
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

206,287. August 31st, 1922.—IMPROVEMENTS RELATING TO INTERNAL COMBUSTION ENGINES, Alfred Hubert Wilde, of Gosford-street, Coventry, and Société Anonyme des Anciens Etablissements Hotchkiss et Cie., of 6, Route de Gonesse, St. Denis-sur-Seine, France.

This invention relates to internal combustion engines, such as motor vehicle engines, of the type in which alternate cylinders are relatively inclined, and the inlet and exhaust passages and valves are arranged in a head or cover secured to the outer ends of the cylinders. The object of the present invention is to provide an improved construction or arrangement of the inlet passage, and also of the exhaust passages in the cylinder head. The head A, by which the outer ends of a group of four cylinders B are covered, is constructed with a closed or endless passage C of approximately elliptical form, the passage being cast integrally with the head and having its major axis situated obliquely across the head. Apertures at one side of the passage open directly into the engine cylinders, and in these apertures the

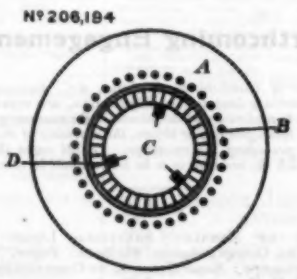


seatings for the inlet valves D are provided. Proceeding from any point along the passage, the order of the cylinder inlet apertures is the same as the "firing" order of the cylinders. At any convenient position, preferably at one side of the head, an opening E is provided for communication with the carburetter. It desired, another opening may be provided at the opposite side of the head. This may communicate with another or the same carburetter. In conjunction with the inlet passages a pair of exhaust passages F are arranged. These are situated at opposite sides of the inlet passage, and each communicates by a pair of openings with a pair of cylinders through valves G. The exhaust passages are also cast integrally with the head, and a portion of one of the side walls of each exhaust passage may be formed by a portion of the walls of the inlet passage. In other words, the inlet passage and each exhaust passage are formed in part by a wall which is common to both. Through this wall an advantageous heat flow may occur from the exhaust to the incoming gases.—*November 8th*, 1923.

DYNAMOS AND MOTORS.

206,194. July 3rd, 1922.—IMPROVEMENTS IN OR RELATING TO ALTERNATING-CURRENT COMMUTATOR DYNAMO-ELECTRIC MACHINES OF LOW STATOR FREQUENCY, *Percy Charles Rushen, of Haseltine, Lake and Co.*, 28, *Southampton-buildings, London, W.C. 2.*

In commutator machines of low stator frequency, particularly those which are used as rear machines in regulating sets—that is to say, commutator machines mounted in cascade with an asynchronous machine and connected with the slip rings of the latter for the purpose of regulating the speed or the phase—

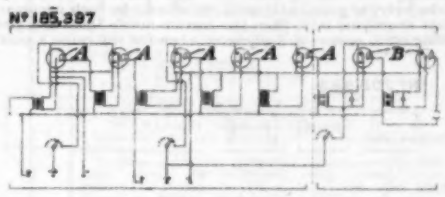


it has been found that difficulties arise in commutation, owing to the small air gap which is necessary in order to keep the magnetisation low. The small air gap causes the pulsating fields originating from the teeth and commutating coils to become strong and disturb the commutation. According to this present invention, commutator machines of low stator frequency are provided with a squirrel-cage winding in the stator, and it has been found that by this arrangement the difficulties are overcome. In the drawing, A indicates the stator of a commutator machine, B the squirrel-cage winding, and C the commutator with the brushes D.—*November 5th*, 1923.

TELEGRAPHS AND TELEPHONES.

185,397. June 30th, 1922.—SELECTIVE AND ANTI-PARASITIC RECEIVING SYSTEM FOR ELECTRO-MAGNETIC WAVES AND ELECTRIC CURRENTS OF CONSTANT FREQUENCY, *International Wireless Appliances Corporation, of 63, Avenue des Champs-Elysées, Paris.*

This invention relates to a receiving system for electro-magnetic waves or electric currents of constant frequency, and is chiefly intended to eliminate the effects due to atmospheric disturbances, which are termed parasite effects, during the reception of messages. The specification describes a selective and anti-parasitic receiving system for electro-magnetic waves or currents of constant frequency. After detection the waves are passed into an amplifying circuit with greatly damped

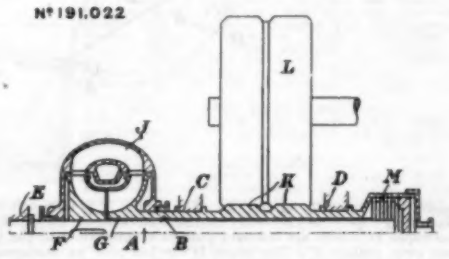


resonance, comprising one or more stages of amplification by thermionic valves A, which are in mutual reaction through transformers, one or more of the circuits being, however, tuned so as to produce local sustained oscillations whose frequency is a multiple or sub-multiple of the frequency of the desired signals which it is proposed to receive. The amplifying circuit is followed by one or more resonance circuits which are tuned to the oscillation resulting from the local sustained oscillation superposed upon the oscillation of the message which it is proposed to receive. The circuits comprise three-electrode valves B, whose saturation is regulated by suitably heating the filaments, whereby the amplitude of the resulting wave due to the parasite effects is brought to the amplitude of the resulting wave due to the desired signals.—*October 30th*, 1923.

TRANSMISSION OF POWER.

191,022. December 19th, 1922.—IMPROVEMENTS IN REVERSIBLE POWER TRANSMISSION DEVICES, Allmanna Svenska Elektriska Aktiebolaget, of Vasteras, Sweden.

The object of this invention is to provide a reversible power transmission device, especially for large amounts of power, which may operate quite soundlessly, both in running forwards and in running backwards, and which does not show any losses of power in forward running. The drawing shows the invention as used for the transmission of power between two shafts, one of which surrounds the other concentrically. A is the driving inner shaft and B is the tubular driven shaft surrounding the shaft A. The shaft B is mounted in bearings C and D, and the shaft A is carried, in part, by the shaft B, and in part by bearings outside thereof. Such a bearing is shown at E. The shaft A carries a pump wheel F, while the shaft B carries a turbine wheel G, having a stationary distributor J connecting the delivery side of the pump wheel to the inlet side of the turbine wheel so as to form a hydraulic gear. The shaft

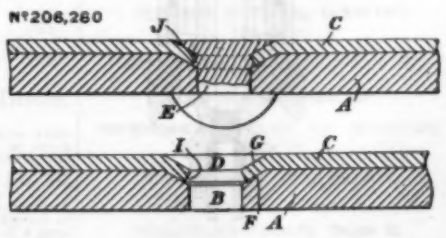


B also carries a double pinion K, meshing in a toothed wheel L attached to the operating shaft. The free ends of the shafts A and B are connected together by a laminated friction clutch M, the bars of which are controlled by means of a hydraulically operated piston. To transmit a non-reversed motion from shaft A and to shaft B, the laminated friction clutch M is thrown into gear, the hydraulic gear being emptied of liquid. The shafts A and B are thus directly coupled together, and will rotate in conjunction, the hydraulic gear at the same time running without load. To obtain backwards running, the clutch M is released and water is passed to the hydraulic gear, which will then first operate as a liquid brake, until it has been completely filled. The pump F will then operate in well-known manner to pass the water through the distributor guide blades J, in which the direction of movement of the water is reversed, and to the turbine G, which is caused, together with shaft B, to rotate in the opposite direction to the direction of movement of the pump wheel and the shaft A.—*November 8th*, 1923.

MACHINE TOOLS AND SHOP APPLIANCES.

206,260. August 10th, 1922.—IMPROVEMENTS IN COUNTERSUNK RIVETING, Ernest Ridgill, of Callywhite-lane, Dronfield, Derby.

This invention relates to an improved method of countersunk riveting, more particularly adapted for attaching thick and thin material or plates together, and also where the rivet heads



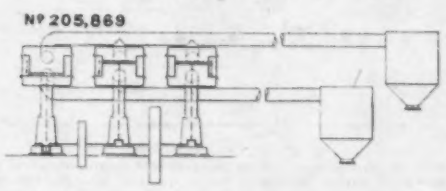
are required to be flush with the face of the thinner materia or plate. In the drawing, A is a thick or inner plate having the hole B, and C is a thin or outer plate having the hole D, and E is the rivet passing through the two holes. F is the countersink formed in the plate A, into which the plate C is forced, so as to produce a countersink G for the countersunk head H formed on the rivet point in the riveting operation. I is the groove result-

ing from the inclination of the edge of the hole D to the countersink F, whereby an extra keying or locking of the rivet E is obtained, in addition to that resulting from the two heads of the rivet, as the body of the rivet is forced into the groove during the riveting operation, as indicated at J. By this improvement a perfectly smooth surface on the outer surface of the thin plate is obtained, and at the same time a stronger jointing of both plates is secured.—*November 8th*, 1923.

CRANES AND CONVEYORS.

205,869. July 24th, 1922.—Pneumatic Conveying Systems, R. Boby, Limited, and M. Jennings, St. Andrew's Ironworks, Bury St. Edmunds.

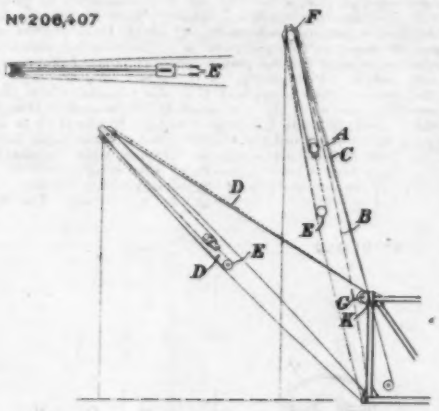
This invention relates to suction or pneumatic systems of handling materials in bulk and more particularly, but not exclusively, to pneumatic grain elevators. In such pneumatic plant employing more than one suction nozzle there is a great falling off in output and efficiency when for any cause a nozzle



(or more than one nozzle) works in free air, thus admitting air to the whole system so freely as greatly to reduce the suction obtainable, sometimes below working level. A system under the control of a single exhauster is consequently divided into two suction circuits worked from opposite sides of an exhauster of the three-cylinder type. Differences in suction in the two circuits do not then give rise, with such exhauster, to harmful peak loads on the prime mover. The illustration needs no description.—*October 24th*, 1923.

206,407. January 13th, 1923.—Improvements in Jib Cranes, Cowans, Sheldon and Co., Limited, and John William Branston, both of St. Nicholas Works, Carlisle.

This invention relates to jib cranes of the type including compensating mechanisms so arranged that the load is huffed in a horizontal or substantially horizontal path. The compensating mechanism comprise as compensating pulley A arranged between the ends of the jib B and adapted to perform translatory move-

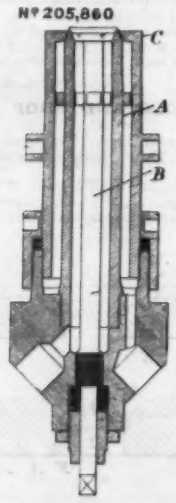


ments longitudinally of the jib. The pulley A is wrapped by the lifting rope C and is bodily movable endwise by compensating ropes D, which are led over pulleys E journalled in the jib and over pulleys F. The ropes D are led over an anchorage pulley G and fixed at K in the crane structure, the axis of the pulley G being approximately at the centre about which the lifting rope C rolls in swinging angularly during luffing operations.—*November 8th*, 1923.

FURNACES.

205,860. July 17th, 1922.—Liquid Fuel Burners, *P. H. Herring*, 8, *The Grove, Church End, Finchley, London, N.* 3.

With this burner it is possible to adjust the orifices for the fuel and the air or steam used for spraying purposes while the burner is in operation. It comprises a fixed tube A, up which the oil



is supplied, an inner stem B terminating in a valve-like head, and an outer tube C with a seating at the top to correspond with the conical end of the fixed tube A. Both the stem B and the tube C can be screwed into or out of the body of the burner, and the orifices for the fuel and air are correspondingly adjusted.—*October 17th*, 1923.

MISCELLANEOUS.

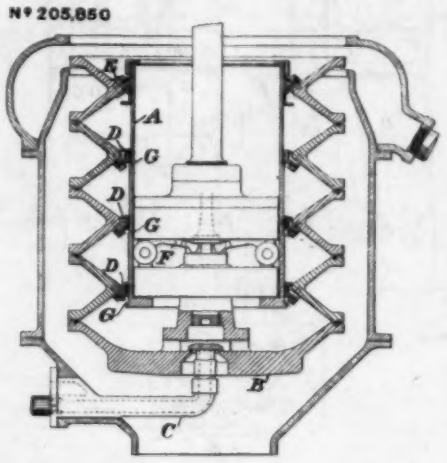
183,464. July 18th, 1922.—Protective Covering for Submarine Cables, Felten and Guilleaume Carlswerk, A.G., of Cöln-Mülheim, Germany.

It has before been suggested to cover an electric cable with a casing of interlocking wires which may be covered, if desired, by a bituminous coating. The present invention relates to the

combination of a tube of interlocking wires with a lead sheath placed externally around the tube. The drawing shows a cross section of the cable made according to the invention, A being the core of any suitable construction, C the tube of interlocking wires, D the lead sheath, B the inner lead sheath, and E the usual outer armouring.—*October 18th*, 1923.

205,850. June 26th, 1922.—Centrifugal Separators, W. Mauss, 72, Cullinan-buildings, Simmonds-street, Johannesburg, South Africa.

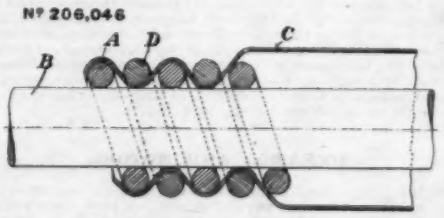
This separator is formed as a series of annular chambers of triangular cross section, mounted on a revolving drum A. At the bottom there is a fixed dish B, into which the material to be separated is delivered by the pipe C. There is an overflow from each annular space into the one above, through spaces D, and the final overflow E is of less diameter than those below. The heavy material separated out is discharged by opening the joints between the rings forming the annular chambers, and for this



purpose the drum A is raised by the toggle mechanism F, when the shoulders G lift the rings successively.—*October 26th*, 1923.

206,046. January 5th, 1923.—Flexible Tubes, Société Anonyme des Etablissements Poberejsky, 18, Rue Soyer Neuilly-sur-Seine, France.

This flexible tubing is intended for the conveyance of petrol or other hydrocarbons. It is made by winding a wire spiral A on a mandrel B. A tube C of cellulose, jointed by means of a



solvent such as alcohol, acetone or cresol, is then slipped over the mandrel and another spiral D of wire wound in the spaces between the spiral A. The surplus material of the cellulose tube is folded into pleats running along the length of the tube.—*November 1st*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Metals: Sheffield Local Section.—University, St. George's-square, Sheffield. Paper, "The Metallurgical Microscope: Some Notes on its Construction and Use," by Mr. J. H. G. Monypenny. 7.30 p.m.

Institute of Metals: Swansea Local Section.—University College, Singleton Park, Swansea. Paper, "Some Applications of the Brinell Hardness Test," by Mr. A. L. Norbury. 7.15 p.m.

Institution of Aeronautical Engineers.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture, "Leader Cable Systems for Electrical Steering of Aeroplanes," by Mr. John Gray. 7.30 p.m.

Institution of Civil Engineers: Yorkshire Association.—Royal Victoria Hotel, Sheffield. Paper, "Low Temperature Carbonisation," by Professor H. E Armstrong. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, S.W. 1. Paper, "Exhaust Valve and Cylinder Head Temperatures in High-speed Petrol Engines," by Professor A. H. Gibson and Mr. H. Wright Baker. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "The L.C.C. Regulations for Steel-framed Buildings," by Mr. S. Bylander. 7.30 p.m.

Physical Society of London.—Imperial College of Science, South Kensington, S.W. 7. Papers: "The Aerodynamic Resistance of Spheres Shot Upward to Measure the Wind," by Mr. L. F. Richardson; "X-Ray Analysis of Zinc-copper Alloys," by Dr. E. A. Owen and Mr. G. D. Preston, B.A.; "Investigations of Piezo-Electric Effects with Dielectrics," by Mr. K. R. Brain, B.Sc.; a demonstration of "The Neon Tube Oscillograph," by Mr. H. St. G. Anson. 5 p.m.

SATURDAY, DECEMBER 15th.

North-East Coast Institution of Engineers and Shipbuilders.—Graduates' visit to the works of Michell Bearings, Limited, Scotswood-road, Benwell. 2.30 p.m.

North of England Institute of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Further discussion on "The Permian Formation in East Durham," by Mr. W. G. Wood. Papers: "The Reinforcement of Buildings and their Foundations Against Mining Subsidence" (illustrated by lantern slides), by Mr. Joseph Eltringham; "The Economic Aspect of Winning Coal Without the Aid of Explosives," by Mr. E. H. Oliver. 2 p.m.

MONDAY, DECEMBER 17th.

Bradford Engineering Society.—Technical College, Bradford. Lecture, "Factory Ventilation, Heating, and Humidifying," by Mr. H. N. Leask. 7.30 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Some Experiments in the Lubrication of Commercial Vehicle Engines," by Mr. H. D. Nickinson. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Informal meeting. Discussion, "Students in Electricity Undertakings," opened by Mr. G. R. A. Murray. 7 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster, S.W. 1. Graduates' Section meeting. "The Management of a Sand and Flint Quarry," by Mr. F. E. A. Manning. 7 p.m.

Institution of Civil Engineers: Newcastle-upon-Tyne Association.—Neville Hall, Newcastle-upon-Tyne. Paper, "Home Railways, the Maintenance of Ways and Works," by Mr. B. P. Fletcher. 7.30 p.m.

TUESDAY, DECEMBER 18th.

Institute of Marine Engineers.—85–88, The Minories, Tower-hill, E. 1. "A Basis for the Explanation of Marine Gear Troubles," by Mr. W. Sellar. 6.30 p.m.

Institute of Transport.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Lecture, "Arterial Roads and their Effect upon Transport," by Mr. H. T. Chapman. 5.30 p.m.

Institution of Automobile Engineers: Coventry Centre.—Railway Hotel, Coventry. Paper, "Automobile Body Engineering," by Mr. W. Ferrier Brown. 7 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Papers: "An Apparatus for the Determination of Carbon Dioxide in Mine Dusts Containing Calcium Carbonate," by Messrs. F. S. Sinnatt and W. Guider; Coal Washing Tests, Part I., "An Apparatus for the Float and Sink Test," by Messrs. F. S. Sinnatt and C. G. Wood. 4 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Further discussion on "The Bio-aeration of Sewage," by Mr. A. J. Martin. 6 p.m.

WEDNESDAY, DECEMBER 19th.

Institution of Automobile Engineers.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Carburation and Induction," by Mr. R. N. Aveline. 7.30 p.m.

Institution of Automobile Engineers: North of England Centre.—Milton Hall, 244, Deansgate, Manchester. Paper, "Automobile Body Engineering," by Mr. W. Ferrier Brown. 6.30 p.m.

Institution of Production Engineers.—The Engineers' Club, Coventry-street, W. 1. Paper, "Electric Furnaces," by Mr. L. W. Wild. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders: Graduate Section.—Lecture Theatre, Neville Hall, Newcastle-on-Tyne. Paper, "Internal Combustion Engines," by Mr. L. C. Leigh. 7.15 p.m.

Royal Meteorological Society.—49, Cromwell-road, South Kensington, S.W. 7. General meeting. 5 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Students' meeting. Second Vernon Harcourt Lecture on "River Training and Maintenance Works," by Mr. R. F. Hindmarsh. 6 p.m.

THURSDAY, DECEMBER 20th.

Institution of Automobile Engineers.—Watergate House Adelphi, W.C. 2. London Graduates' meeting. Discussion "Brake Design as Exemplified by the Commercial Vehicle Show," opened by Messrs. D. J. Macklin and H. E. Merritt. 7.30 p.m.

Institution of Locomotive Engineers.—The Engineers' Club, Coventry-street, W. 1. "Notes on Locomotive Running Trials," by Mr. E. A. Phillipson. 7 p.m.

Institution of Structural Engineers.—Denison House, 296, Vauxhall Bridge-road, S.W. 1. "Practical Designing of Structural Steelwork: Beam Connections and Clarke's Loading," by Mr. J. B. Clarke. 7.30 p.m.

Demonstration of Industrial and Shop Lighting Effects.—The Junior Institution of Engineers visited the demonstration rooms of the British Thomson-Houston Company, Limited, on Friday evening, December 7th, 1923, to hear a lecture and witness demonstrations of industrial and shop lighting effects. The lecture was given, and the demonstrations carried out, by Mr. W. Millner, A.M.I.E.E., the company's illuminating engineer. Some scientific charts dealing with the acuity of vision, speed of discrimination, sustained vision and speed of accommodation, were thrown on the screen. The curves on these charts were, it was explained, the result of tests carried out in several industries, and they pointed to the fact that one's ability to see was considerably increased under high intensities of illumination. Mr. Millner also put forward some very interesting figures obtained from actual tests in various industries, which proved that production was considerably increased when higher intensities of light were used. After the lecture and demonstrations a discussion took place between the members upon the lighting of offices and industrial interiors, the lighting of drawing-offices being discussed to some length.